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ABSTRACT

This document was developed to stimulate others to attempt the writing of a mathematics-based core curriculum. It contains the following sections: (1) The Definition of a Core Curriculum; (2) Reasons Why One Should Use or Not Use a Core Curriculum in a Teaching-Learning Situation; (3) The Thoughts of Other Educators Concerning A Math-Based Core Curriculum; and (4) A Definition of, A Model For, and the Organization of A Math-Based Core Curriculum. The objectives for the various subject areas of this curriculum were gleaned from the fifth-grade level of various mathematics, language arts, social studies, and science guides and other educational media. It is hoped that individuals interested in African or Afro-American studies might find this material of interest. Aspects of Black Studies are intertwined into the social studies objectives for this curriculum. The document concludes with an extensive bibliography. (MP)

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An Inquiry Concerning The Core Curriculum Concept In General, The Math Based Core Curriculum Concept In Particular And A Model For The Development of A Math Based Core Curriculum

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by

Kirk P. Mullen

Adviser: Dr. Martin Johnson

Report submitted to Dr. Martin Johnson in partial fulfillment of the requirements for the degree of Master of Education

I recommend that this paper be accepted as a seminar paper required for the Master of Education degree.

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SE039107

This paper is dedicated to Walter McArtis and to Stephen J. Taylor who knew what to say, when to say it and to whom the saying came naturally.

Thanks.

This paper is also dedicated to all ethical persons and humanists.

ABSTRACT

Title of Thesis: An Inquiry Concerning The Core Curriculum Concept in General, The Math Based Core Curriculum Concept In Particular And A Model For The Development of A Math Based Core Curriculum

Kirk P. Mullen, Master of Education, 1982

Thesis Directed by: Dr. Martin Johnson, Associate Professor of Elementary Education, Department of Education, University of Maryland

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The purpose of this paper was to stimulate others to attempt the writing of a math based core curriculum. The author felt that those persons not privy to a mathematical understanding of the world environment would be the same persons least likely to be able to defend themselves against national or international domination. The author believed that constantly coming into contact with many different situations requiring quantitative thought and the generalization of the relationships involved in these situations was one of the best ways to foster a mathematical understanding of the environment and thereby foster personal and national independence.

The author has firstly attempted an investigation of the various definitions of a core curriculum; secondly, an exploration of the writings of others with regard to the value of utilizing a core curriculum has been presented; thirdly, a discussion of the writings of others concerning a math based core curriculum has been offered; lastly, the author used the aforementioned data by presenting a definition of and a model for a core curriculum plus objectives for a math based core curriculum, a taxonomy of those objectives, and an example of a possible lesson plan taken from this type of a curriculum.

The objectives for the various subject areas of this math based core curriculum were gleaned from the fifth grade level of various math, language arts, social studies, and science curriculum guides and other educational media. It was believed that persons interested in African or Afro-American studies

might also find this curriculum of interest due to the intertwinement of these subjects into the social studies objectives for this curriculum.

TABLE OF CONTENTS

Page

INTRODUCTION.....1

THE DEFINITION OF A CORE CURRICULUM.....3

REASONS WHY ONE SHOULD USE OR NOT USE A CORE CURRICULUM IN A TEACHING-LEARNING SITUATION.....12

THE THOUGHTS OF OTHER EDUCATORS CONCERNING A MATH BASED CORE CURRICULUM.....27

A DEFINITION OF, A MODEL FOR, AND THE ORGANIZATION OF A MATH BASED CORE CURRICULUM.....58

BIBLIOGRAPHY.....128

INTRODUCTION

This author operates under certain beliefs. One of these beliefs is that the skeletons of the technologically advanced countries are made of the quality and quantity of information taken from the world environment. It is a further belief that those countries privy to more information have more options in terms of the maintenance of their policies than do those with less information. Another belief is that the same holds true on an individual level.

Mathematics is a science which is necessary for an advanced technological state to function. This being so, it stands to reason that those persons not privy to a mathematical understanding of the world environment are the ones who are least likely to be able to defend themselves from either national or international domination. It is for this reason that this writer believes that constantly coming into contact with many different situations requiring quantitative relationships and the generalization of these relationships is one of the best ways to foster a mathematical understanding of the environment as well as being one of the best ways to foster personal and national independence. The logical outgrowth of these beliefs from an educational perspective is a multifaceted curriculum which interrelates mathematics, language arts, science, and social studies.

It shall be the attempt of this writer to firstly, present an investigation of the various definitions of a core

curriculum; secondly, present an investigation of what other writers have said concerning the value of using a core curriculum approach to teaching and learning; thirdly, a discussion of what others have said concerning a math based core curriculum will be presented and lastly the reader will be presented with this writer's conception of a core curriculum. This will contain a definition, a model for the curriculum, objectives used within the curriculum, a taxonomy of the objectives, and an example of a possible lesson plan.

This curriculum is being written to stimulate others to attempt the writing of a math based core curriculum based on this model. It is hoped that the day will come when many persons will organize themselves to produce a K-12 math based core curriculum.

THE DEFINITIONS OF A CORE CURRICULUM

Over the years many definitions of a core curriculum have been proposed. It is the aim of this section of this paper to present many of these definitions to the reader.

Mills was the first writer to be investigated. She chose as her definition of a core curriculum the following:[1]

> A core curriculum embodies certain classroom conditions. These conditions are that a single class is conducted by one teacher for a block of time made up of two or more periods. The core curriculum for the most part replaces social studies and the communicative arts but does not merely combine these subjects because instruction is centered around problem solving so that the subject matter of the core may take on a functional meaning.

Harold Alberty chose as his definition, the following:[2]

> All or part of the total curriculum which is required of all students at a given level makes up the core curriculum. The core designates all or part of the program of general education.

Alberty noted that six situations existed which exhibited core curricula.[3] These situations were the following:

1. The core curriculum consisted of a number of logically organized subjects or fields of knowledge each one of which was to be taught independently.

2. The core curriculum consisted of a number of logically organized subjects or fields of knowledge, some or all of which are correlated.

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[1] Ruth Ina Mills, "The Nature of Problem Solving and Its Application to Core Curriculum," (Ph.D. dissertation, University of Maryland, 1959), p.12.

[2] Harold Alberty, Reorganizing the High School Curriculum, revised edition. (New York: The Macmillan Company, 1953), p.167.

[3] Ibid.

3. The core curriculum consisted of broad problems, units of work, or unifying themes which were chosen because they afforded the means of teaching effectively the basic content of certain subjects or fields of knowledge. These subjects or fields retained their identity, but the content was selected and taught with special reference to the unit, theme, or problem.

4. The core curriculum consisted of a number of subjects or fields of knowledge which were unified or fused. Usually one subject or field (e.g. history) served as the unifying center.

5. The core curriculum consisted of learning experiences selected from broad preplanned problem areas, in terms of the psychobiological and societal needs, problems, and interests of students.

6. The core curriculum consisted of broad teacher-student planned units of work, or activities, in terms of needs, problems, or interests as perceived by the group. No basic curriculum structure would have been set up.

Faunce and Bossing state that in modern education the term came to be applied to that part of the experience curriculum which is concerned with those types of experiences thought necessary for all learners in order to develop certain behavior competencies necessary for effective living in a democratic society.[4]

Lucille Lurray and Elsie Alberty defined a Core Curriculum as, "...consisting of broad, preplanned problem areas defined by the faculty in terms of the common personal-social needs, problems and interests of adolescents in this society."[5]

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[4]Roland C. Faunce and Nelson L. Bossing, Developing the Core Curriculum, second edition. (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1958), p.54.

[5]Lucille L. Lurray and Elsie J. Alberty, Developing A High School Core Program, (New York: The Macmillan Company, 1957), p.27.

Smith, Stanley and Shores determined that, "...a core curriculum emphasizes social values" and believed that "...the structure of the core curriculum is fixed by broad social problems or by themes of social living."[6]

Stalzer believes that the core curriculum consists of that portion of the curriculum which is basic for all students and which is made up of learning activities that are organized without regard to conventional subject matter boundaries.[7] For her, "The core program is organized in terms of problem areas, broad preplanned areas of living in which youth usually have problems rather than in terms of organized knowledge. From these problem area. learning units are developed cooperatively in the classroom by teacher and students."[8]

For Schonbuch, Solomon and Harris, the core curriculum consists of a prearranged block program of courses for which a student registers.[9] For the New York State Education Department,

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[6]B. Othanel Smith, William O. Stanley, and J. Harlan Shores, Fundamentals of Curriculum Development, revised edition. (Yonkers-on-Hudson, N.Y.: World Book Company, 1957), pp. 314, 317.

[7]Elsie J. Stalzer, "Contributions of Mathematics to a Proposal for Reorganizing General Education in Secondary Schools on the Basis of a Core Program," (Ph.D. dissertation, Ohio State University, 1959), p. 440.

[8]Stalzer, p. 5.

[9]Stanley S. Schonbuch, Barton S. Solomon, and Joseph Harris, "The Core Experience: A Quantitative and Qualitative Analysis," (Arlington, Va.: ERIC Document Reproduction Service, ED 075025), 1971.

the core curriculum consists of those topics which are necessary for those persons taking their place in the national work force.[10]

Barton believed that the integration and emphasis into the curriculum of social values through student input, made for the core curriculum. For her, the core of society consisted of its basic values or rules by which people govern or should govern their actions.[11] Black believed that when diverse areas of human study were linked and interpenetrated this would provide sufficient basis for the formation of a core curriculum.[12] Boyer and Kaplan believed that a core curriculum dealt with the common human experiences of an inherited past, the challenges of the present, the making of the future and the making of value choices.[13] Nisbet and Mertens devised a core for the training of biologists. For

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[10] New York State Education Department, Bureau of Occupational Career Curriculum Development, Math Unit 6: A Core Curriculum of Related Instruction for Apprentices, (Arlington, Va.: ERIC Document Reproduction Service, ED 122030), 1967.

[11] Betty R. Barton, "Equal Time for Students, A Plug for the Core Curriculum," American Vocational Journal 49, (October 1974) pp.57-8.

[12] Sidney J. Black, "Utopia As Reality," College English 33, (December 1971), p.304.

[13] Ernest L. Boyer and Martin Kaplan, "Educating for Survival: A Call for a Core Curriculum" Change 9(March 1977) pp.22-24.

them, this curriculum included the necessary subject matter, the laboratory techniques, and the approaches to problem solving that other biology teachers believed would be necessary for one to function as a competent biologist.[14]

John White and Alan Harris wrote opposing articles regarding a core curriculum. Harris chose not to define the term, stating that if one were developed, it would be arbitrary and unsatisfactory because it would be bent in favor of the ideology of the most powerful political pressure group and not towards the desires of the curriculum theorists.[15] It was the belief of White that Harris took any curriculum that dealt with the basic needs of all school aged children on a national level as a core curriculum; although this was not specifically stated by Harris.[16]

Peel and Nussbaum regarded an interdisciplinary course (a course that combined the basic teachings of two or more fields of knowledge) as a core course.[17]

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[14]Jerry J. Nisbet and Thomas R. Mertens, "Curriculum Reform at Ball State University," The American Biology Teacher 33(January 1971),p.37.

[15]Alan Harris, "The Impossibility of a Core Curriculum," Oxford Review of Education 3 Number 2, 1977,p.171.

[16]John White, "The Impossibility of a Core Curriculum: A Reply to Alan Harris," The Oxford Review of Education 3 Number 2, 1977,p.181.

[17]Malcolm L. Peel and Leo L. Nussbaum, "The Core Course Redivivus," Liberal Education(December 1974),p.478.

Walker's belief was similar to White's in that he believed that the basics that all children in a national school system should get, comprised the core curriculum.[18] Jenkins stated that the use of a theme, topic, issue, or, problem of human importance as an organizing focus for a teaching or learning unit constituted integrated studies (a core curriculum).[19] Bailey believed that a core curriculum was made up of those ideas which were essential and often used with relationship to the job that one sought.[20] Reardon believed that the term core curriculum referred to that form of curriculum organization which provided learning experiences needed by all young people in a framework which allowed for the combination or fusion of two or more basic subjects and block-time class scheduling.[21] For Reardon block-time scheduling was defined as the curriculum practice of allowing two or more normal class periods to be held consecutively.[22]

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[18]George Walker, "How Common Can You Get," The Times (London) Educational Supplement, September 26, 1975, p.23.

[19]David Jenkins, "Cross-Fertile Teaching," The Times (London) Educational Supplement, June 11, 1971, p.4.

[20]Frank A. Bailey, "A Model Core Curriculum in Mathematics for Four Fields of Non-Engineering Technology in the Two Year College," (Ph.D.dissertation, Auburn University,1972), pp.iv-v.

[21]William G. Reardon. "The Core Program Recent History, Present Status, and Projected Impact for Future Education." (Ph.D. dissertation, Indiana University, 1972), p. 15.

[22]Ibid.

Reardon also allowed for another definition of a core curriculum. He stated that the required subjects in the curriculum which every student took could comprise the core curriculum.[23]

As an aid to the reader, a chart has been provided in which the reviewed writers have been juxtaposed with their definitions of the term core curriculum. A few writers who will be mentioned in the following section of this paper have chosen not to define the term core curriculum. They have not been mentioned in this section but have been placed in the chart with the accompanying phrase of "No definition given."

It has been the aim of this writer to expose the reader to as many definitions of the term core curriculum as possible. This having been done, it is believed that the reader is now ready for the reasons why one should use or not use a core curriculum in a teaching-learning situation.

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[23] Ibid., p.28.

CHART I

Reviewed Writers and a Summary of Their Definitions of the Term Core Curriculum

Reviewed Writers	Definitions of the Term Core Curriculum
Mills	A single class is conducted by one teacher for two or more periods. Social studies and the communicative arts are combined with instruction centering on problem solving.
H. Alberty	All or part of the total curriculum which is required of all students at a given level
Faunce and Bossing	The experiences thought necessary for all learners in order to behave competently and effectively in a democratic society
Lurray and E. Alberty	Faculty determined broad preplanned problem areas concerned with the personal/social needs, problems, and interests of teenagers in this society
Smith, Stanley and Shores	Emphasizes social values and is fixed by broad social problems or by themes of social living
Stalzer	That which is basic for all students and is made up without regard for conventional subject matter boundaries
Schonbuch, Solomon and J. Harris	Prearranged block program of courses
N.Y. State Education Dept.	Those topics necessary for persons taking their places in the national work force
Barton	Students decide which social values should be emphasized and integrated into their academic life.
Black	The linking and interpenetration of diverse areas of human study

CHART I(Continued)

Reviewed Writers and a Summary of Their Definitions of the Term Core Curriculum

Reviewed Writers	Definitions of the Term Core Curriculum
Boyer and Kaplan	Composed of the common experiences of an inherited past, the challenges of the present, the making of the future and the making of value choices
Nisbet and Mertens	The necessary subject matter, laboratory techniques and approaches to problem solving
A. Harris	Chose not to define; believed that such a curriculum would be arbitrary and slanted toward the desires of the most powerful political group and away from the desires of the curriculum theorists
White	Deals with the basic needs of all school aged children, on the national level
Peel and Nussbaum	A course in which the teachings of two or more fields are combined
Walker	The basics that all children in the national school system should get
Jenkins	The use of a theme, topic, issue or problem of human importance as an organizing focus
Bailey	The essential and often used ideas pertinent to the job that one seeks.
Reardon	a. The experiences needed by all young people and presented in such a way that two or more basic subjects are combined for two or more consecutive periods b. The required subjects which every student takes
Morris	No definition given.
Margolis	No definition given.

REASONS WHY ONE SHOULD USE OR NOT USE A CORE CURRICULUM IN A TEACHING-LEARNING SITUATION

The following reasons have been ascertained from most of the previously mentioned authors concerning the use or non-use of a core curriculum.

Mills interviewed teachers who had core class pupils in subject areas outside the core program to give their impressions of the work habits of the core pupils as compared to those of pupils in conventional classes. Mills learned that the teachers felt the core pupils were (1) more willing to assume extra responsibility, (2) showed more concern for fellow classmates, (3) were better able to follow directions and (4) were more inclined to think for themselves.[1]

Faunce and Bossing believed that a core curriculum should be used when concern for those types of learners' experiences which were thought necessary for effective living in a democratic society, were exhibited.[2]

Schonbuch, Solomon, and Harris developed four reasons for using core curricula. They believed that core curricula should be used when (1) they would facilitate the breakdown of the traditional divisions between academic disciplines; (2) they would promote greater intimacy in the classroom;

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[1] Mills, p.47.

[2] Faunce and Bossing, p.54.

(3) they would help students perceive the teacher in a more realistic way, as a human being and not as an impersonal instructor; and (4) they would encourage a transfer of knowledge and enthusiasm between disciplines.[3]

The New York State Education Department believed that a relevant instruction for apprentices preparing for a variety of trades, would utilize a core approach in order to deal with the wide variety of persons entering apprenticeship programs.[4]

John L. Morris had personal experience with a core curriculum. His self contained eighth grade class chose as its problem the building of a very large model airplane. It was Morris's belief that a core curriculum should be used so that students can better understand a subject that they might deal with as adults, such as the stock market. He also believed that a core curriculum increased enthusiasm for learning.[5] Barton dealt with the training of individuals for health care occupations and believed that core curricula emphasized the primary worth of the individual and required that learners participate in shaping the general nature of the educational program in which they were involved. She also believed that a core curriculum provided the opportunity

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[3] Schonbuch, Solomon, Harris, p.1.

[4] New York State Education Department,p.3.

[5] John L. Morris, "Mathematics As A Core Unit,: The Arithmetic Teacher, February 1973, p.110.

for meeting the needs of all students through a combination of common and unique learning experiences. Lastly, she believed that a core curriculum lent itself well to individualization.[6] Black believed that a core curriculum facilitated the student's understanding of the total curriculum in all departments and that it lent itself to many variations in theme, style, content, and method from both the student and faculty perspectives. Black also believed that this type of curriculum satisfied the need for variety and originality in both of these perspectives.[7]

It was the belief of Boyer and Kaplan that a core curriculum should be used in order to insure social survival in this and in the next century. They believed that survival would be more likely when the education of students was centered around common human experiences such as an inherited past, the challenges of the future and the making of value choices.[8]

Nisbet and Mertens reported on the institutionalization of a core curriculum in the Ball State University Biology Department. It was decided by the faculty at this university that the core program should be used to insure adequate basic laboratory and field techniques. They also wished to make sure that proper articulation of one course with

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[6]Barton, p.58.

[7]Black, p.304.

[8]Boyer and Kaplan, pp.22;24.

another would be built into the program. Lastly, the faculty chose a core approach so that they could assure themselves that a balance existed between the various aspects of the biology curriculum.[9]

Harris came out against the use of a core curriculum stating that if one were developed it would be arbitrary and unsatisfactory because it would be bent in favor of the ideology of the most powerful pressure group and not towards the desires of the curriculum theorists. He also states that if politics could be kept out of the formation of a core curriculum, the curriculum theorist would still find it impossible to agree on a sensible basis for a core curriculum.[10] Harris also gives three educational ideologies that could influence a core curriculum and thus invalidate it. The ideologies are (1) classical humanism; (2) progressivism; and (3) reconstructionism.

White presents a reply to Harris stating that he agrees with Harris that the classical humanist and progressive ideologies are not adequate for modeling a core curriculum but that he sees nothing wrong with the reconstructionist ideology.[11] Harris defines the reconstructionist educational ideology as the formulation of a society along more democratic lines with everyone playing a full part in creating

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[9]Nisbet and Mertens, p.34.

[10]Harris, p. 171.

[11]White, p. 182.

a proud, self-reliant nation.[12] Harris reduces this ideology to one that educates the masses for society's needs and says that there are many different opinions as to what society needs. White on the other hand suggests that reconstructionist core curriculum theorists not look to the differences between them but to the commonalities that they have.[13] White also says that persons who have fundamental differences might not differ on curriculum objectives. He presents his case thus:[14]

> Take someone opposed to all forms of abortion on religious grounds and set him against a supporter of abortion on demand -- an apparently irreconcilable gulf here. But both parties could agree that, as far as curricular objectives go, all children should be exposed to all the main arguments for and against abortion.

White believes that the product the curriculum theorists should strive for when no common ground can be obtained, can be an understanding of the positions in dispute and the intellectual tools with which the students can make up their own minds.[15]

Peel and Nussbaum believed that a core curriculum would help faculty from different disciplines share and learn from one another and also that students would broaden their horizons. They also believed that this type of curriculum would give assistance to staff members in their growth

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[12]Harris, p.173.

[13]White, p.182.

[14]White, p.183.

[15]White, p.183.

as teachers through regular sharing of instructional problems, pedagogical techniques, and common goals.[16]

It was the belief of Margolis that there was a need to ensure that a student was receiving a continuous, systematic, coordinated educational program.[17] It was for this reason that he chose the core format.

Reardon found reasons for and against the use of the core curriculum. Some of the reasons for using a core curriculum were ascertained through a questionnaire given to core practitioners. These reasons were:[18]

1. The core curriculum helped students to see relationships between subject matter.
2. The core curriculum gave students a chance to practice democracy in the classroom.
3. The core curriculum got the students involved in developing their own curriculum and also their concepts of themselves.
4. The core curriculum showed the interrelationships of subject matter as well as the interrelationship of school and civilian life.
5. There was the hope on the part of the core practitioners that students would become independent learners.

Reardon also found that specialists in the field of core curriculum felt that young people had become a supportive force for core concepts. He cited Shores' and Var's

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[16]Peel and Nussbaum, pp. 478, 480.

[17]Leonard Margolis, The Special Education Core Curriculum Manual, Basic Level, Learning Skills, Oral Language, Reading, Mathematics, (Arlington, VA: ERIC Document Reproduction Service, ED 169695, 1979, p.1).

[18]Reardon, P.80.

statements concerning the desire of students for education to come to grips with society's problems.

Shores stated that:[19]

> The openness idea and the idea of trying to get with it in terms of current social problems support the core concept...and many schools are being forced in this direction, not so much by parents as they are by kids. It's hard to change structures and the kids are pushing hard for this.

Vars added:[20]

> ... the personalization, humanization, relevance and student involvement -- this kind of thing provides support. Plus we are getting a lot of support from the students and others that education come to grips with... major social issues like pollution and the population explosion.

According to Reardon, Van Til believed that those persons who operate from a psychological framework of reference and talk about humanistic education support core curricula.[21] Also persons who worked with core curricula in the past and persons connected with laboratory schools were also supporters of the core concept.[22]

Reardon noted that Faunce listed four concepts and beliefs that support the core curriculum. These concepts and beliefs are:[23]

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[19]Reardon quoting Shores in Reardon's dissertation, p.107.

[20]Reardon quoting Vars in Reardon's dissertation, p.107.

[21]Reardon, p.108.

[22]Reardon, p.109.

[23]Reardon, p.110.

1. The concern with involving the learner in planning his own education.

2. The concern with and belief in humane education, the rights of young people, the interdisciplinary approach, and in team teaching.

3. The preoccupation with the civil rights of boys and girls and the efforts to establish their rights.

4. The concern of young people for the "social, economic, and political issues that confront them as they arrive at voting age."

Reardon found several reasons for not using a core curriculum among the national specialists that he interviewed. These specialists felt that a major reason for opposing core curricula stemmed from the lack of teacher training in the utilization of such a curriculum in college. The specialists also believed that there was a tendency on the part of the classroom teachers to adhere to the traditional curriculum with its divided subjects and that this would be another factor affecting the acceptance of the core curriculum. Further, the specialists believed that the lack of effective resource materials and the lack of communication between core and non-core teachers and among proponents of core curricula locally and nationally has fostered nonacceptance and opposition on the part of educators regarding core curricula. Lastly, these specialists believed that the lack of adequate evaluation of the results of this type of curriculum have hindered its acceptance.[24]

Stalzer is for the use of a core curriculum because she believes that the problems of humanity in general and youth

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[24]Reardon, pp. 111-112.

in particular cannot be solved by tackling them through a single subject approach. She believes that an interdisciplinary approach must be tried for problems which cross subject lines.[25] Smith, Stanley, and Shores believe that a core curriculum is used when one wants to use "the school as an instrument for deliberate social reconstruction and reinterpretation."[26] They believe that one builds "...the curriculum around the persistent social problems that arise in the course of carrying on the common social processes of society."[27]

Lucille Lurray and Elsie Alberty believed that a core program should be used to help adolescents grow in the following ways:[28]

1. Through their understanding and competent performance of their obligations as members of the family, the community, the state, the nation, and the world.
2. Through their understanding of democratic principles; by skillfully thinking through their own problems and helping to think through problems common to their group, and in appreciation for and willingness to improve democracy as a way of life.
3. Through the skills and knowledge of social and moral principles involved in getting along with themselves and others.

Harold Alberty did not directly state why a core program should be used but said the meeting of the common needs and problems of adolescents by the school was done by a core

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[25] Stalzer, p.10.

[26] Smith, Stanley, Shores, p.314.

[27] Ibid.

[28] Lurray and Alberty, pp. 28,29.

program.[29]

Bailey developed a math core curriculum and believed that such a curriculum should be used because specific vocations needed certain types and depths of mathematical knowledge and that greater math teaching only confused most students.[30]

Jenkins and Walker were both writing about British schools. Jenkins believed that a core program should be used to enable man to control his personal and social world.[31] Walker believed that a core program should be used in order to keep from classifying students and to treat them as individuals with equal rights to all resources. He expected all students to partake in roughly the same intellectual challenges and to travel through the same intellectual processes, but to do so at their individual paces.[32] Walker also believed that the core program helped students to manipulate knowledge, make judgments, draw conclusions, make comparisons, and suggest predictions. He believed that their abilities were essential to keep Britain from developing into a two-tiered state composed of those having these abilities and those not having these abilities. He believed those persons able to manipulate knowledge would control those persons without this ability and that a

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[29] H. Alberty, p.169.

[30] Bailey, pp.2-3.

[31] Jenkins, p.4.

[32] Walker, p.23.

resulting destructiveness or violence would eventuate among those not able to manipulate knowledge.[33]

A chart has been provided for the reader for the purpose of aiding the juxtapositioning of the reviewed writers with their reasons for using or not using a core curriculum.

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[33]Walker, p.23.

CHART II

Reviewed Writers and Their Reasons for Using a Core Curriculum

Reviewed Writers	Reason for Using a Core Curriculum
Mills	1. Students were more willing to assume extra responsibility. 2. Students showed more concern for fellow classmates. 3. Students were better able to follow directions. 4. Students were more inclined to think for themselves.
Faunce and Bossing	Promotes experiences thought necessary for living in a democratic society
Smith, Stanley and Shores	To use the school as an instrument for deliberate social reconstruction and reintegration
Stalzer	The problems of humanity in general and youth in particular must be solved through an interdisciplinary approach because their problems cross subject lines.
Schonbuch, Solomon and J. Harris	1. To breakdown the divisions between academic disciplines 2. To promote greater intimacy in the classroom 3. To help the student perceive the teacher as a human being and not as an impersonal instructor 4. To encourage the transfer of knowledge and enthusiasm between disciplines
N.Y. State Education Dept.	A variety of persons need to be prepared for a variety of trades.
Barton	Emphasizes the primary worth of an individual and requires that learners participate in shaping the general nature of the educational program in which they are involved
Black	1. To facilitate the student's understanding of the total curriculum in all departments 2. It lends itself to many variations in theme, style content and method from both the student and faculty perspectives. 3. The need for variety is satisfied in both perspectives.

CHART II(Continued)

Reviewed Writers and Their Reasons for Using a Core Curriculum

Reviewed Writers	Reasons for Using a Core Curriculum
Boyer and Kaplan	To insure social survival through education centered around common human experiences
Nisbet and Mertens	1. To insure adequate basic laboratory and field techniques 2. To insure the proper articulation of courses 3. To insure that a balance existed between the various aspects of the biology curriculum
White	1. To promote the reading of the commonalities found among different groups with different opinions 2. To understand disputed positions 3. To provide the intellectual tools with which the students can make up their own minds
Peel and Nussbaum	1. To help the faculty from different disciplines share and learn from one another 2. To help students broaden their horizons 3. To give assistance to staff members in their growth as teachers by sharing instructional problems, pedagogical techniques, and common goals
Bailey	Specific vocations need certain types and depths of mathematical knowledge and greater math teaching only confuses most students.
Reardon	1. To see relationships between subject matter 2. To practice democracy in the classroom 3. Students develop their own curriculum and their concepts of themselves. 4. To show the interrelationship between subject matter, the school, and civilian life 5. To promote independent learning 6. Young people supported core learning because it came to grips with society's problems. 7. Provides a humanistic framework of reference for the educational process

CHART II(Continued)

Reviewed Writers and Their Reasons for Using a Core Curriculum

Reviewed Writers	Reasons for Using a Core Curriculum
	8. Persons involved with core curricula in the past and persons involved with laboratory schools supported core curricula. 9. Promotes team teaching 10. Concern for the civil rights of boys and girls 11. The concern of young people for social, economic, and political issues as they approach voting age
Morris	1. So students can better understand a subject that they might deal with as adults 2. Increased students enthusiasm for learning
Margolis	To insure that a student receives a continuous, systematic coordinated educational program
H. Alberty	To meet the common needs and problems of adolescents
Lurray and E. Alberty	1. Students grow through their understanding and competent performances of their obligations as members of the family, the community, the state, the nation, and the world. 2. Students grow through their understanding of democratic principles; by skillfully thinking through their own problems and helping to think through problems common to their group, and in appreciation for and willingness to improve democracy as a way of life. 3. Students grow through the skills and knowledge of social and moral principles involved in getting along with themselves and others.
Jenkins	To enable man to control his personal and social world

CHART II (Continued)

Reviewed Writers and Their Reasons for Using a Core Curriculum

Reviewed Writer	Reasons for Using a Core Curriculum
Walker	1. To keep students from being classified and to treat them as individuals 2. To help students manipulate knowledge, make judgments, draw conclusions, make comparisons, and suggest predictions 3. To keep Britain from developing into a state of knowledge manipulators and those not able to manipulate knowledge

CHART IIA

Reviewed Writers and Their Reasons for Not Using a Core Curriculum

A. Harris	1. It would be arbitrary and unsatisfactory because it would be bent in favor of the ideology of the most powerful political group and not toward the desires of the curriculum theorists 2. It would be impossible to agree on a sensible basis for a core curriculum 3. It would be invalidated by the classical humanist, progressive, and reconstruction ideologies
Reardon	1. Lack of teacher training in the utilization of such in college 2. A tendency on the part of classroom teachers to adhere to the traditional curriculum with its divided subjects 3. The lack of effective resource materials 4. The lack of communication between core and non-core teachers and proponents locally and nationally 5. The lack of adequate evaluation of the results of this type of curriculum

THE THOUGHTS OF OTHER EDUCATORS CONCERNING A MATH BASED CORE CURRICULUM

It shall be the attempt of this writer to put forth the ideas of three core educational programs which have as their intent a thorough integration of mathematics with at least one other area of the curriculum. The United Science and Mathematics for Elementary Schools (USMES) program along with the programs of Frank A. Bsiley and Elsie Stalzer have been chosen. The following organizers shall be used in discussion of the three core programs; these are: (1) the goals of that program; (2) the rationale behind the program; (3) the content of the program and its target audience; (4) the teaching-learning style of the program; and (5) the methods of evaluation used within the program.

United Science and Mathematics for Elementary Schools (USMES)

Goals

The word curriculum should not be applied to the USMES program because it was designed as a supplement to the regular curriculum.[1] It is being dealt with though because it is believed by this writer that it is an excellent example of the intertwining of subjects and of the breaking down of barriers separating subjects.

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[1] The USMES Guide, (Newton, Massachusetts: Education Development Center, 1974), p.29.

USMES grew out of a resolution adopted at the 1967 Cambridge Conference on the Correlation of Science and Mathematics in the schools. This was a gathering of scientists, mathematicians, and educators who believed that in a technological society ordinary citizens needed an education that resulted in an understanding of science to the extent that specific problems were approached in a logical manner.

The USMES designers aimed to convince students of the usefulness of science and mathematics in society by involving them in research and development projects which required the use of mathematics, science, social studies, and language arts.[2] Placing these academics in practical situations meaningful to the students was done not just to build skills more efficiently but to provide practice in responsible, self-determined use of skills. The USMES designers believed that the decisions which adults have to make required the ability to understand a situation; that is, to observe, organize, quantify, predict, and control that situation.[3] Acquiring these abilities and being able to apply them thoughtfully were the deeper purposes of the USMES program.[4]

The rationale for teaching children problem solving through mathematics and science grows out of a belief that students learn through experience and that they will learn

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[2]USMES Guide, p.9.

[3]USMES Guide, p.15.

[4]USMES Guide, pp. 1,15.

more from a real experience than from a contrived one.[5] The USMES developers see four important educational advantages to basing USMES units on real life problem solving activities.[6] They believe motivation is heightened in the students because of their expectation of bringing about a change that will be useful to them and their school. They believe that the students will be proud of their accomplishments and that they will grow up to appreciate the power of applied intelligence. Secondly, the designers believe that high standards will result from a student's need for success and correctness in order to attain an important goal. Thirdly, a problem-solving approach to learning requires that the problem be analyzed by the students so that they can decide which aspects of it they need to investigate. This is a skill the designers believe all people need. Fourthly, the designers believe that problems leading to real projects do not have artificial data or requirements nor are they overly simplified. Real problems are more likely to develop all the aspects of good problem solving. These are observation, quantification, simplification of the problem, applying judgment, formulation and trial of successive models for change, acquisition of needed skills, and the development of a critical faculty.

Content and Target Audience

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[5]USMES Guide, p.11.

[6]Kathleen Devaney and Lorraine Thorn. Elementary Mathematics: Nine Programs, (San Francisco, California: Far West Laboratory for Educational Research and Development, 1974), p.190.

Content and Target Audience

All USMES units focus primarily on the processes included in problem solving. The specifics that receive emphasis in the units are observing, data gathering, hypothesizing, interviewing, designing and building test apparatus, controlling variables, statistical analysis, recording data accurately and efficiently, making and disseminating products, testing procedures, writing evaluations and improving small group dynamics. These activities are blended with concepts and skills developed in mathematics, natural and social sciences and the language arts. USMES is a supplementary program for the students and as such is not meant to replace the regular curriculum. It is geared for all socioeconomic, cultural, and intellectual backgrounds from kindergarten through the eighth grade.[7]

Teaching-Learning Strategy

One USMES unit should be engaged in by the class two or three times a week and from 45 to 60 hours over a three to eight month period. Because there are no set deadlines for the completion of a unit, teachers can afford to let students make mistakes. This freedom to make mistakes allows students to fully investigate a problem and to learn from the trial of various solutions. It is assumed by the developers that concepts not learned through USMES will be covered at some other time during the school day by the teacher.[8] During USMES

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[7] Devaney and Thorn, p.197.

[8] Devaney and Thorn, p.197.

time though, a teacher's function is to suggest, coordinate, and extend activities for individual students, groups, and the class as a whole.[9]

USMES uses a discovery learning approach to imparting its concepts wherein students are expected to learn through observing the results of their own experiences and those of their classmates.[10] They are encouraged to learn from the needs they discover as they proceed toward the solutions of their problems. The view then of discovery learning is between "guided discovery" in which everything the student is supposed to discover is planted beforehand by the teachers or by the project developers, and "messing around" wherein the student obtains no concept after his or her activity.[11]

An USMES teacher has responsibilities that have not been previously mentioned; they are:[12]

1. To introduce the problem in a meaningful way that not only allows the students to relate it to their particular situation but also opens up general avenues of approach for the solution of the problem.

2. To provide the tools and supplies necessary for initial hands-on work in the classroom or laboratory.

3. To be patient while letting the children make their own mistakes and find their own way and to offer assistance only when a student is near his/her point of frustration.

4. To provide frequent opportunities for group reports and exchanges of ideas through class discussions.

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[9] USMES Guide, p.23.

[10] Devaney and Thorn, p.196.

[11] Devaney and Thorn, p.196.

[12] USMES Guide, p.25.

5. To ask the appropriate questions to stimulate the student's thinking so that he/she will increase the depth of his/her investigation.

6. To be quite adept at classroom management.

Evaluation Within USMES

The staff of the Education Development Center believed that USMES should be evaluated through the use of tests of problem solving, a classroom activity and interaction scale and the reading comprehension and mathematics computation subtests of the Stanford Achievement Test.[13] The data gathered from these three instruments provided information on whether the USMES approach was successful in teaching real problem solving, produced a different kind of classroom atmosphere in terms of activities and interaction and whether USMES had an effect on student's basic reading and math skills.[14] The results of the problem solving test were as follows: There were no discernible differences betwwen the USMES and the control classes with regards to (1) whether any of the reasons given for the solution to a particular problem were based on factors that were measurable within the test solution and (2) whether the choice was based on personal opinion, a suggested test, or a performance test. In the post-test every USMES class altered its scores to reflect (1) predominantly quantifiable reasons for a choice of solutions, and (2) higher levels of proof involving suggested or performed tests.[15] With regard to the Stanford reading and

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[13] USMES Guide, p.10.

[14] USMES Guide, p.11.

[15] USMES Guide, p.12.

mathematics subtests, the results showed that the "real" problem-solving style of learning, was able to add the problem-solving process without diminishing the rate of learning the basic facts, skills, and concepts of math and reading and that no significant difference existed between the USMES classes and the control classes.[16] In other words, students using USMES did not lose anything in the basic skills while they were improving their problem-solving abilities. Finally, the comparison between USMES and control classes with regard to the types of classroom activity and interaction found that USMES classes were (1) much more likely to be involvd in small group work, (2) more likely to go from whole group work to small group work to whole group work, (3)more likely to contribute new ideas, (4) more likely to debate or argue points, and (5) more likely to have child-child interaction.[17] The control classes were found to have more child-teacher interaction and less likely to be involved in the four other above mentioned ideas.[18] The students in the control classes were more likely to answer specific questions posed by the teacher as opposed to the USMES students.[19] The control and the USMES classes did not differ on the amount of time spent in whole

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[16] USMES Guide, p.12.

[17] USMES Guide, p.13.

[18] USMES Guide, p.13.

[19] USMES Guide, p.13.

group activities.[20] Because the USMES students tended to have more child-child interactions and also tended to have more debates than the control group, it was the belief of this writer that the USMES group could be classified as learning more independently of the teacher than the control group.

Three charts have been provided for the reader. The first chart, chart number three, details the extent that each unit develops overall skills, processes and concepts in the areas of mathematics, science, social studies, and language arts. In the second chart, the units are charted as to the types of class/group discussion, data collection, data representation and analysis and construction activities involved in them. In the third chart, the reader can determine at a glance the extent that each unit develops specific computational inquiry, and construction skills along with specific mathematics, science, social science, and language arts concepts. These charts have been taken from pages 78-83 of the USMES Guide.

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[20] USMES Guide, p.13.

CHART III

OVERALL STRENGTH OF USMES IN MATH, SCIENCE, SOCIAL SCIENCE, AND LANGUAGE ARTS

	Mathematics	Science	Social Studies	Language Arts
Dice Design	1	3	2	2
Burglar Alarm Design	3	1	2	3
Pedestrian Crossings	1	2	1	1
Lunch Lines	1	2	1	1
Describing People	1	3	1	1
Consumer Research-Product Testing	2	1	1	2
Designing for Human Proportions	1	3	2	2
Soft Drink Design	1	3	3	2
Traffic Flow	1	2	2	1
Electromagnet Device Design	1	1	3	3
Play Area Design and Use	1	2	2	1
Weather Predictions	1	1	3	2

CHART III (continued)

	Mathematics	Science	Social Studies	Language Arts
Manufacturing	2	2	1	2
Advertising	2	3	1	1
Classroom Design	1	1	2	2
Bicycle Transportation	1	2	1	1

1=extensive development of skills, processes, and concepts
2=moderate development of skills, processes, and concepts
3=some development of skills, processes, and concepts

CHART IV - MAJOR ACTIVITIES IN USMES UNITS

	Dice Design	Burglar Alarm Design	Pedestrian Crossings	Lunch Lines	Describing People	Consumer Research-Product Testing	Designing for Human Proportions	Soft Drink Design	Traffic Flow	Electromagnet Device Design	Play Area Design	Weather Predictions	Manufacturing	Advertising	Classroom Design	Bicycle Transportation
Class/Group Discussions																
making decisions on tasks & procedures	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
making predictions	X				X	X				X		X				
organizing & carrying out group work	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
preparing & presenting verbal & written reports	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Data Collection																
making observations & collecting data on everyday occurrences			X	X					X		X			X	X	X
designing questionnaires & conducting surveys			X		X	X	X	X	X		X		X	X	X	X
making time & distance measurements			X			X	X		X		X	X	X		X	X
making force (strength) measurements						X				X	X		X			
making measurements of heat or light						X						X			X	
Data Representation and Analysis																
representing data graphically (bar graphs, line graphs, histograms, scatter graphs, pie graphs)			X	X	X	X	X		X		X	X	X	X	X	X
making Venn diagrams					X	X		X								
making triangle diagrams of fractions or ratios	X		X	X	X		X	X	X				X	X		X
finding statistical descriptors (average, median, range, quartile range, mode)	X		X	X	X	X	X	X	X		X	X	X	X	X	X
Construction																
measuring instruments			X	X	X		X		X		X	X			X	X
test instruments		X				X				X						
scale models			X	X					X		X				X	X
electrical & mechanical devices		X	X						X	X		X			X	
furniture & clothing							X	X					X		X	
other	X										X		X	X		X

CHART V - MAJOR SKILLS, PROCESSES, AND CONCEPTS PRACTICED IN USMES UNITS

	Dice Design	Burglar Alarm Design	Pedestrian Crossings	Lunch Lines	Describing People	Consumer Research-Product Testing	Designing for Human Proportions	Soft Drink Design	Traffic Flow	Electromagnet Device Design	Play Area Design and Use	Weather Predictions	Manufacturing	Advertising	Classroom Design	Bicycle Transportation
Computational Skills																
counting and comparison of sets of data	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1
addition, subtraction, multiplication	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1
division	2		3	3	1	1	1	1	1	1	1	1				
comparing ratios or fractions	3		3	3	1	1	1	2	3	3	2	3				
making approximations and measurements	3		1	1	1	1	1	1	1	1	1	1				
Inquiry Skills																
defining a problem	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
recognizing variables	2	1	2	2	1	1	1	1	2	1	2	1	1	1	2	2
categorizing and ranking information and data	2		2	1	1	2	1	2	2	1	1	1	2	1	2	2
determining accuracy & validity of measurements and tests	1	3	1	1	2	1	2	2	1	1	2	1	1	2	1	3
making graphic representations of data	1		1	1	1	2	1	1	1	1	2	1	1	1	2	2
making statistical analyses, interpolations, & extrapolations of data	1		1	1	2	2	2	2	1	2	2	1	2	1	2	2
finding correlations	3	2	3	3	1	2	1	1	3	1	2	1	1	1	2	2
designing experiments with controlled variables	2	2	3	3	2	1	3	1	3	1	2	3	2	1	3	2
mathematical modeling			1	1					1				3			
formulating and testing hypotheses	2	1	3	3	1	2	3	2	3	1	2	1	3	2	2	3
Construction Skills	2	1	2	3	3	2	1	3	2	1	1	1	1	1	1	1
Math Concepts																
structure of integers	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1
structure of real numbers	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1
set structure					1			3					3	3		3
symmetry, geometrical relationships	1		2	2					2		2		3		2	2
probability and statistics	1		1	1	1		1	2	1		2	1	2	1	2	2
sampling			2	2	1	1	1	1	2		2	2	1	1		2
Science Concepts																
elements in scientific inquiry	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1
variability & reproducibility of experimental results	1	1	2	2	2	1	1	1	2	1	2	1	3	2		3
structure of matter		1				1				1	2	1	2		2	3
time, distance, and motion studies			1	1		1			1		1	1	1	2	2	1
heat, light, & electricity studies		1	3	3		1			3	1		1			1	
pressure and force studies						1					1	1	3			
Social Science Concepts																
interpersonal relationships			2	2	1	2	1	2	2	2	1	2	2	2	2	2
factors in group work	2	2	1	1	2	2	2	1	2	2	2	2	2	2	2	2
dissemination of information	1	1	1	1	2	1	2	1	2	3	2	2	3	1	3	1
individual differences & commonalities					1		1				1		1	1	2	
examination of values	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Language Arts																
letter writing			1		2	1	1	2	1		1	2				1
writing reports based on investigations		2	1	1		1	1		1		1					
group presentations	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
writing questionnaires & interview questions			2	1		1		1	2				1	1	1	1
writing advertisements						2		2					2	1		2

Frank A. Bailey - A Model Core Curriculum in Mathematics for Four Fields of Non-Engineering Technology in the Two-Year College.

Goal

Bailey believed that a core curriculum was made up of those ideas which were essential and often used with relationship to the job one sought.[21] His purpose was to develop a model core curriculum in mathematics for two-year non-engineering programs in electronics technology, machine shop technology, drafting technology, and automotive technology. He had another goal -- to identify and program in sequence the mathematical skills and concepts common to these technologies with sub-branches out to a point where commonality no longer existed.[22] Bailey believed that students in non-engineering technology did not need a theoretical knowledge of algebra, trigonometry, analytic geometry, and calculus. What was needed was a skill oriented knowledge of advanced arithmetic, algebra, geometry, trigonometry and the slide rule. This he determined by reviewing over 200 two-year college catalogs.[23]

Bailey did not state his reasons for wanting to use a core curriculum format for learning and teaching but it is believed by this writer that this format was chosen because

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[21] Bailey, pp.iv,v.

[22] Bailey, p.1.

[23] Bailey, p.2.

Bailey believed that specific vocations needed certain types and depths of mathematical knowledge and that greater mathematics teaching only confused most students.[24] This would concur with Bailey's belief in teahing what was essential and often used with regard to the job that one sought.

Curriculum Content and Target Audience

As stated earlier, the target audience for this curriculum would be those persons in two-year colleges, taking the non-engineering technology courses dealing with automobiles, drafting, machine shop and electronics.

The curriculum content can best be presented using Bailey's chart. It has been copied from pages 99 through 110 of his dissertation. It is a 23 module mathematics core curriculum wherein the modules have been programmed in sequence to permit maximum understanding of the topics (although some of the modules and sub-modules are independent enough that they can be taken out of sequence and omitted entirely).

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[24]Bailey, pp.2.3.

BAILEY'S CORE CURRICULUM CHART

Modules		Automotive Technology	Drafting Technology	Machine Shop Technology	Electronics Technology
Module 1:	Natural Numbers				
1.1	Definition of natural numbers	**	**	**	**
1.2	Addition of natural numbers	**	**	**	**
1.3	Subtraction of natural numbers	**	**	**	**
1.4	Multiplication of natural numbers	**	**	**	**
1.5	Division of natural numbers	**	**	**	**
1.6	Definition of equation	*	**	**	**
1.7	Solution of simple equations in natural numbers	*	**	**	**
Module 2:	Integers				
2.1	Definition of intergers	**	**	**	**
2.2	Addition of integers	**	**	**	**
2.3	Subtraction of integers	**	**	**	**
2.4	Multiplication of integers	**	**	**	**
2.5	Division of integers	**	**	**	**
2.6	Solution of simple equations in integers	*	**	**	**
Module 3:	Real Numbers				
3.1	Definition of rational numbers	**	**	**	**
3.2	Definition of irrational numbers	**	**	**	**

BAILEY'S CORE CURRICULUM CHART (continued)

Modules		Automotive Technology	Drafting Technology	Machine Shop Technology	Electronics Technology
3.3	Definition of real numbers	**	**	**	**
3.4	Addition of rational numbers	**	**	**	**
3.5	Subtraction of rational numbers	**	**	**	**
3.6	Multiplication of rational numbers	**	**	**	**
3.7	Division of rational numbers	**	**	**	**
3.8	Operations of real numbers	**	**	**	**
3.9	Solution of equations in real numbers	*	**	**	**
Module 4:	Simple Equations With One Unknown				
4.1	Construction of equations	*	**	*	**
4.2	Solution of equations	*	**	**	**
Module 5:	Ratio				
5.1	Definition of ratio	**	**	**	**
5.2	Ratio of integers	**	**	**	**
5.3	Ratio of real numbers	**	**	**	**
5.4	Definition of proportion	**	**	**	**
5.5	Solution of proportions	**	**	**	**
Module 6:	Percent				
6.1	Definition of percent	**	**	**	**
6.2	Percents as fractions	**	**	**	**

BAILEY'S CORE CURRICULUM CHART (continued)

Modules		Automotive Technology	Drafting Technology	Machine Shop Technology	Electronics Technology
6.3	Changing decimals to percent	**	**	**	**
6.4	Changing percents to decimals	**	**	**	**
6.5	Using proportions with percents	**	**	**	**
Module 7:	Squares and Square Roots				
7.1	Definition of the square of a number	*	**	**	**
7.2	Square of real numbers	*	**	**	**
7.3	Definition of sqaure root of a number	*	**	**	**
7.4	Square root of perfect sqaures	*	**	**	**
7.5	Square root of real numbers using tables	*	**	**	**
7.6	Long-hand square root process		*	*	**
7.7	Square root of algebraic expressions		*		**
Module 8:	Interchange of Metric Units				
8.1	The metric system	**	**	**	**
8.2	The English system	**	**	**	**
8.3	Changing from the English system to the metric system	**	**	**	**
8.4	Changing from the metric system to the English system	**	**	**	**

BAILEY'S CORE CURRICULUM CHART (continued)

Modules	Automotive Technology	Drafting Technology	Machine Shop Technology	Electronics Technology
Module 9: Monomials and Polynomials				
9.1 Definition of monomial		**		**
9.2 Definition of polynomial		**		**
9.3 Addition of monomials and polynomials		**		**
9.4 Subtraction of monomials and polynomials		**		**
9.5 Multiplication of monomials and polynomials		**		**
9.6 Division of monomials and polynomials		**		**
Module 10: First Degree Equations With Two Unknowns				
10.1 Construction of equations with two unknowns		**		**
10.2 Solutions of equations with two unknowns		**		**
Module 11: Rectangular Coordinates				
11.1 Definition of rectangular coordinates	*	**	**	**
11.2 Quadrants	*	**	**	**
11.3 Graphs of linear equations with two unknowns	*	**	**	**
11.4 Graphic solutions of linear equations with two unknowns		**	**	**

BAILEY'S CORE CURRICULUM CHART (continued)

Modules	Automotive Technology	Drafting Technology	Machine Shop Technology	Electronics Technology
Module 12: Pythagorean Theorem				
12.1 The Pythagorean theorem	*	**	*	**
12.2 Solving right triangles using Pythagorean theorem	*	**	*	**
Module 13: Algebraic Fractions				
13.1 Defintion of algebraic fractions	*	**	*	**
13.2 Addition of algebraic fractions	*	**	*	**
13.3 Subtraction of algebraic fractions	*	**	*	**
13.4 Multiplication of algebraic fractions	*	**	*	**
13.5 Division of algebraic fractions	*	**	*	**
Module 14: Exponents				
14.1 Definition of exponent	*	**	*	**
14.2 Addition of exponents for finding the product of powers of a base	*	**	*	**
14.3 Zero exponent	*	**	*	**
14.4 Negative exponents	*	**	*	**
14.5 Subtraction of exponents for finding the quotient of powers of a base	*	**	*	**

BAILEY'S CORE CURRICULUM CHART (continued)

Modules	Automotive Technology	Drafting Technology	Machine Shop Technology	Electronics Technology
14.6 Multiplication of exponents for finding the power of a power	*	**	*	**
14.7 Division of exponents in fractional form	*	**	*	**
14.8 Powers of ten	*	**	*	**
14.9 Multiplication of powers of ten	*	**	*	**
14.10 Division of powers of ten	*	**	*	**
Module 15: Quadratic Equations				
15.1 Definition of factors		*		**
15.2 Factoring of monomials and polynomials		*		**
15.3 Construction of quadratic equations		*		**
15.4 Solution of quadratic equations		*		**
Module 16: Solution of Equations With Rational Expressions				
16.1 Construciton of equations with rational expressions	*	**	*	**
16.2 Solution of equations with rational expressions	*	**	*	**
Module 17: Estimation				
17.1 Estimation of practical problems	*	**	*	**
17.2 Checking solutions of problems using estimation	*	**	*	**

BAILEY'S CORE CURRICULUM CHART (continued)

Modules	Automotive Technology	Drafting Technology	Machine Shop Technology	Electronics Technology
Module 18: Logarithms				
18.1 Definition of logarithms		**	*	**
18.2 Multiplication using logarithms		**	*	**
18.3 Division using logarithms		**	*	**
18.4 Power of a power using logarithms		**	*	**
18.5 Roots using logarithms		**	*	**
Module 19: Complex Numbers				
19.1 Definition of imaginary numbers		*		**
19.2 Definition of complex numbers		*		**
19.3 Operations with complex numbers		*		**
Module 20: Trigonometry				
20.1 Definition of trigonometric functions	*	**	**	**
20.2 Use of trigonometry tables	*	**	**	**
20.3 Trigonometric solutions of right triangles	*	**	**	**
Module 21: Radians				
21.1 Definition of radian measures		**	*	**
21.2 Conversion of radian measures to degree measures		**	*	**

BAILEY'S CORE CURRICULUM CHART (continued)

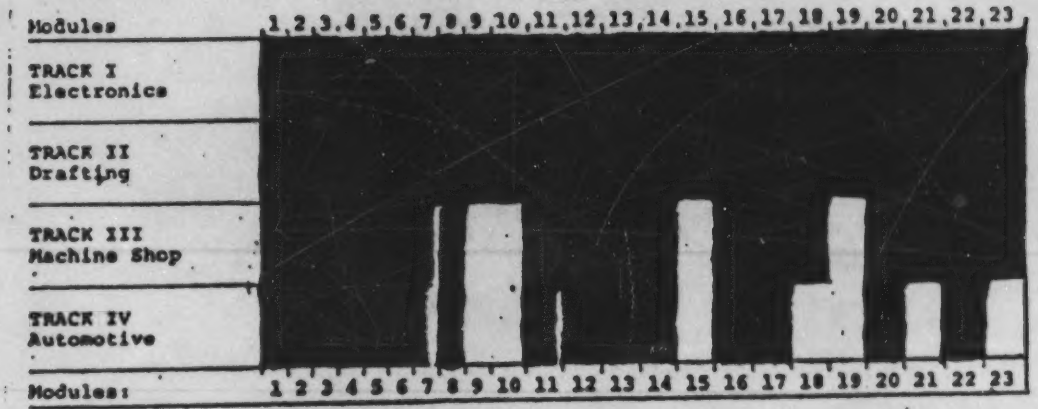
Modules		Automotive Technology	Drafting Technology	Machine Shop Technology	Electronics Technology
21.3	Conversion of degree measure to radian measure		**	*	**
Module 22: Vectors					
22.1	Definition of vectors	*	**	*	**
22.2	Addition of vectors	*	**	*	**
22.3	Subtraction of vectors	*	**	*	**
22.4	Magnitude of a vector	*	**	*	**
Module 23: Polar Coordinates					
23.1	Definition of polar coordinates		*	*	**
23.2	Changing rectangular coordinates to polar coordinates		*	*	**
23.3	Changing polar coordinates to rectangular coordinates		*	*	**
23.4	Graphs using polar coordinates		*	*	**

**--Essential or often used
*--Seldom used

The following figures represent the extent of use of the ideas in each of the 23 modules for the four technologies. The figures are taken from pages 111 and 112 of Bailey's dissertation.

FIGURE 1

CORE REPRESENTING MODULES ESSENTIAL, OFTEN USED OR SELDOM USED

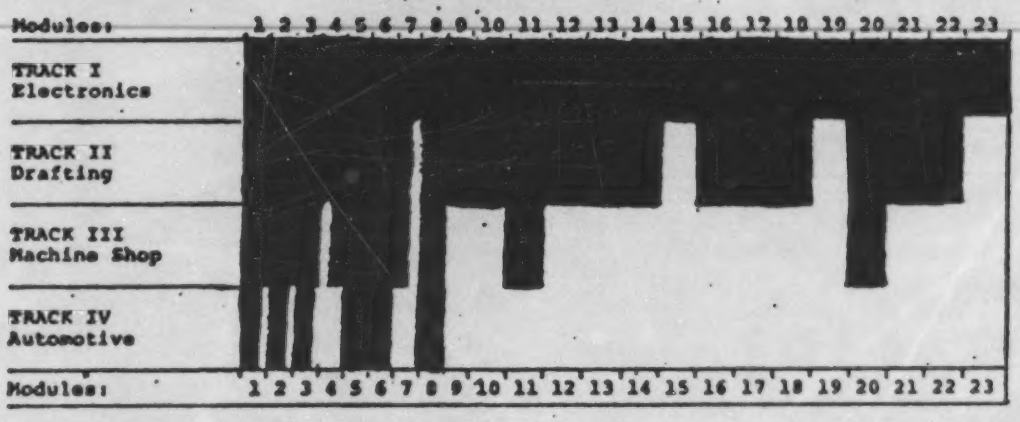

Modules 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
TRACK I Electronics
TRACK II Drafting
TRACK III Machine Shop
TRACK IV Automotive
Modules: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

The shaded area in Figure 1 represents the core and indicates the modules and sub-modules that are essential, often used or seldom used in each track.

The unshaded area in Figure 1 represents the modules that contain material which the respondents in this study indicated in never used in the respective tracks. For example, automotive technology did not use sub-modules 7.6 and 7.7, and machine shop technology did not use 7.7. Refer to Table 22 for similar identification of other sub-modules.

FIGURE 2

CORE REPRESENTING MODULES ESSENTIAL OR OFTEN USED


Modules: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
TRACK I Electronics
TRACK II Drafting
TRACK III Machine Shop
TRACK IV Automotive
Modules: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

The shaded area in Figure 2 represents the core and indicates the modules and sub-modules that are essential or often used in each track.

The unshaded area in Figure 2 represents the modules that contain material which the respondents in this study indicated is seldom used in the respective tracks. Refer to Table 22 for identification of sub-modules.

Teaching - Learning Strategy

A specific teaching-learning strategy was not delineated by Bailey but it is presumed that the student would learn the necessary mathematics concepts as he came upon them while learning his vocation. Bailey mentioned that four sets of laboratory activities (one set for each of the four technologies), should be developed to apply the mathematical skills and concepts to each of the technologies.[25] Bailey also said that a variety of instructional methods should be used to test the mathematics content for each technology as well as the laboratory activities. Again, he did not mention any particular instructional methods.[26]

Evaluations Within Bailey's Curriculum

The evaluation of students' progress was dealt with by Bailey through the use of whatever instructional methods were deemed adequate for testing the mathematics content and laboratory activities for each technology, although he did not specifically say this nor did he ever become specific as to the measurement of a student's progress. Bailey does produce a form which was checked (✓) by E.L. Kurth and others at Auburn University as to the adequateness of the mathematical skills and concepts listed in his core curriculum.[27] Bailey also accepted the evaluation of department

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[25]Bailey, pp.121-122.

[26]Bailey, p.122.

[27]Bailey, p.135.

chairmen in the fields of drafting, machine shop, and automotive technology located at two-year non-engineering technology colleges.[28] With regard to electronics, Bailey accepted the assertions of Simmons and Barlow and Schill. Simmons' work which influenced Bailey was "Surveying the Mathematics Preparation of Today's Electronics Technicians," found in the September 1960 issue of School Shop.[29] Barlow and Schill's work which influenced Bailey was The Role of Mathematics in Electrical-Electronic Technology, a dissertation presented at the Los Angeles campus of the University of California in 1962.[30]

Elsie June Stalzer - Contributions of Mathematics to a Porposal for Reorganizing General Education in Secondary Schools on the Basis of a Core Program.

As mentioned earlier in this paper, Stalzer believed that the core curriculum consisted of that portion of the curriculum which is basic for all students and which is made up of learning activities that are organized without regard to conventional subject matter boundaries.

Goal

Stalzer's goal of her research was to organize a core curriculum pertinent to the problem of adolescents as members of society. From these problem areas, learning units were to be developed cooperatively in the classroom by the

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[28] Bailey, p.12.

[29] Bailey, pp. 13-14.

[30] Bailey, pp. 13-14.

teacher and the students. Stalzer tried to determine the possible contributions of mathematics to the selected problem areas. This was to provide the basic curricular structure to her core program.[31]

Rationale

Stalzer believed that the problems of humanity in general and of youth in particular could not be solved by tackling them through a single subject approach and, as such, an interdisciplinary approach had to be tried for problems which cross subject lines.

Curriculum Content and Target Audience

Stalzer's curriculum was geared toward adolescents in secondary school. The problem areas that were chosen were the following:

1. Orientation to school living
2. Self understanding
3. Developing values and beliefs
4. Forming social relationships in a democracy
5. Employment and vocation
6. Conserving natural resources
7. Education in American democracy
8. Constructive use of leisure
9. Family living
10. Communication
11. Democratic government
12. Personal and community health
13. Economic relationships in a democracy
14. Critical thinking
15. Achieving world peace in the atomic age
16. Intercultural relations

Stalzer determined from the January 1942 issue of School Science and Mathematics that 53 mathematical concepts were needed to carry out the learning activities considered

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[31] Stalzer, p.9.

appropriate for the adolescent problem areas of her curriculum. These 53 concepts were grouped under the six main concepts of number, measurement, relationship, proof, operation, and symbolism and are below listed.[32]

Number

1. Whole number
2. Number system
3. Fraction
4. Decimal
5. Directed number
6. Exact number
7. Approximate number
8. Denominate number

Measurement

9. Direct measurement
10. Indirect measurement
11. Standard unit
12. Approximation
13. Estimating
14. Possible error
15. Relative error
16. Accuracy
17. Precision
18. Significant figures
19. Scale drawing

Relationship

20. Variable
21. Constant
22. Approximate relationship
23. Functional relationship
24. Dependent variable
25. Independent variable
26. Tabulation of data
27. Mean
28. Median
29. Mode
30. Normal frequency distribution
31. Formula
32. Graphical representation
33. Extrapolation
34. Interpolation
35. Correlation
36. Trend

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[32]Stalzer, pp.29-32.

Proof

37. Deduction
38. Induction
39. Assumption
40. Hypothesis
41. Definition
42. Undefined term
43. Relevance
44. Reliability
45. Representativeness

Operation

46. Counting
47. Addition
48. Subtraction
49. Multiplication
50. Division
51. Rounding off
52. Comparison

Symbolism

53. Mathematical symbolism

Teaching - Learning Strategy

Stalzer's core curriculum was organized in terms of broad pre-planned areas of living in which youth usually have problems rather than in terms of organized knowledge. From these problem areas, learning units were developed cooperatively in the classroom by teacher and students. One-third to one-half of the school day was devoted to the understanding and solution of a problem. The utilization of field trips and community surveys were two ways that data were to be collected during the core time period. The students and teacher were to collectively and democratically work towards the solution of the problem in such a way that the interrelationship of the factors which lead to the

solution of the problem were emphasized.[33]

Evaluation

Stalzer did not present a formal method of evaluation for her core curriculum. She did though pose the question, "Can math be learned in the core?" and replied that this was open to question and that the answering of this question was beyond the scope of her study.[34] She also posed a second question to the reader. That question was, "Can math be learned in a framework where in all probability, it will not be encountered in the logical systemic form?"[35] To this question she presented the following affirming data concerning the New York City schools which showed that when core students were compared with non-core students they achieved at approximately the same level.[36] In this evaluation, student assessment was in the areas of reading, work-study skills, language usage and expression, and arithmetics. The study that Stalzer mentioned was J.W. Wrightstone's "Evaluation of the Experiment with the Activity Program in the New York City Elementary Schools," from the Journal of Educational Research, Volume 38, December 1944, pp.252-257.

In answering the last question, Stalzer also refers to the work of Harding and Bryant. They found that functional uses of arithmetic were as good a learning device as drill

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[33] Stalzer, p.6.

[34] Stalzer, p.434.

[35] Stalzer, p.435.

[36] Stalzer, p.435.

for developing computational skills and direct first-hand experiences with projects were better than vicarious experiences and drill procedures in developing the ability to solve problems.[37]

Stalzer quoted one person whose research negated that of Harding and Bryant and of Wrightstone. This person was Hanna. It was Hanna's conclusion that a "richness and vitality of arithmetic experiences" served to give pupils "significant meaning and purposes," but he reasoned that "functional experiences of childhood are alone not adequate to develop skills."[38]

In this section of this paper an attempt was made to present to the reader information concerning a mathematics based core curriculum as favored by (1) the Unified Science and Mathematics in the Elementary Schools program, (2) Frank A. Bailey, and (3) Elsie J. Stalzer. The one commonality that the three espoused programs had was the use of mathematics as a tool for the solution of either a work-related problem or a problem of human relations nature.

At this point in this paper, three of the four reasons for writing it have been explored and presented to the reader. In the next section the reader shall be presented with this writer's definition of a math based core curriculum. Also presented to the reader will be a model for such a curriculum, the objectives utilized in this model curriculum, a taxonomy for such a curriculum and a lesson plan for it.

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[37]Stalzer, p.435.

[38]Stalzer, p.437.

A DEFINITION OF, A MODEL FOR, AND THE ORGANIZATION OF A MATH BASED CORE CURRICULUM

Thoughts Concerning the Need for a Math Based Core Curriculum

The one thought in the back of this writer's mind motivating the synthesis of the following curriculum concerns the relationship between knowledge and the power of a person to control his life. It is quite apparent that the more clear a person's concepts are concerning mathematics, the more options that person has in terms of the present world technology. These options are increased when one realizes that just as the industrialized nations need the mathematically literate person so also do the partially industrialized and the non-industrialized nations. Because there is and will be for a long time, this demand for the mathematically literate person, he does not have to restrict himself to a life style that he might find oppressive. He has the power to explore other life styles and thereby, has greater autonomy.

It has been this writer's belief that the greater the frequency of contact with mathematics, particularly when that contact came within different situations; the greater the chance that more mathematics would be understood by the pupil. This thought is based on the student's ability to see the math concept in its pure math setting and also its application or development in a scientific or sociological

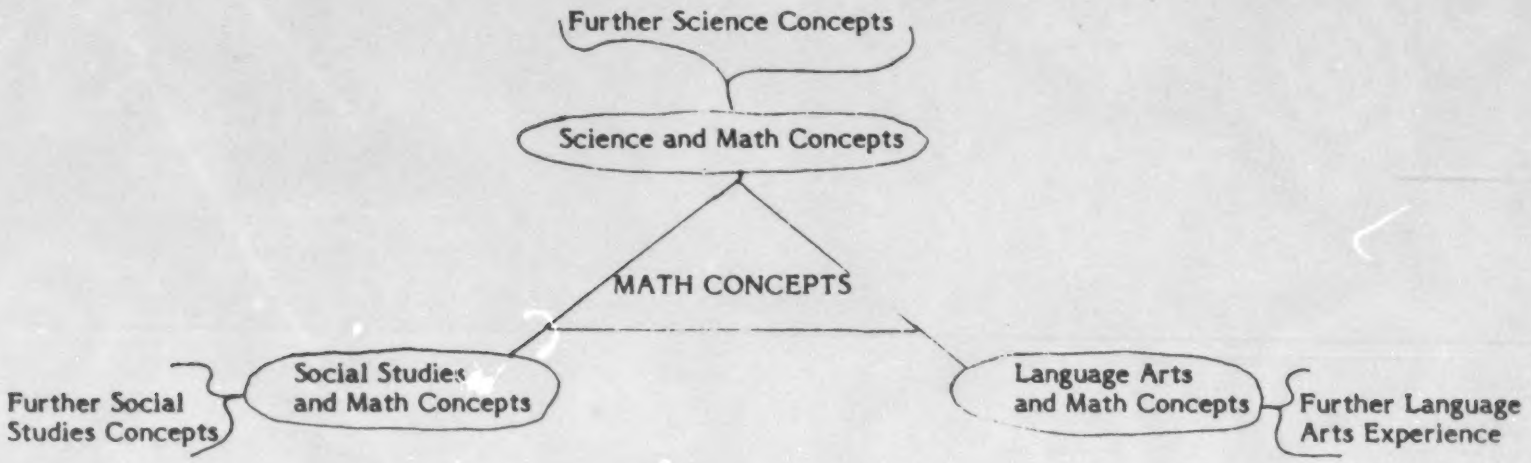
setting as well as rethink the concept through the verbal modalities of speaking, listening, reading and writing. It has been the attempt of this writer to synthesize the previously mentioned idea into what he calls a math based core curriculum.

A Definition for, and a Model of, a Math Based Core Curriculum

A math based core curriculum is a course of study which dictates that the concepts studied in the mathematics will be demonstrated, developed, or analyzed in the fields of science, social studies, and language arts. In the model below, the math concepts are in the triangle. They are the core, the center, the ideas around which the rest of the curriculum is based. The lines radiating from the core are the classroom activities which demonstrate, develop, or analyze a particular math concept in either science, social studies, or language arts. This intermingling of concepts is represented within the ellipses. It is from these intermingling areas that further exploration of the subjects and of their non-math components may begin. It is also possible to begin in one of the three brackets and then work inward towards the particular math core concept. This method might be considered when the topic is something extraordinary such as a televised rocket launching or an impending holiday.

DIAGRAM 1

MODEL FOR A MATH BASED CORE CURRICULUM



The Organization of a Math Based Core Curriculum

An attempt was made to devise an adequate and easy method for the building of a core curriculum. This was done out of the belief that one person's math core curriculum might not meet the needs of someone else.

The math based core curriculum was synthesized from various subject curricula, the format of which would complement this author's conception of a core curriculum. This model curriculum was drawn from some of the math, science, social studies, and language arts competencies pertinent to the fifth grade. These concepts were also placed in a taxonomy for the easy perusal of the reader. Finally, the reader has been presented with three lesson plans illustrating the math core concept.

Math Competencies

The following list of math competencies is taken from the Course Goals in Mathematics, K-12 published by the Tri-County Development Project.[1] The competencies concern the ideas pertinent to rational numbers and their study by fifth grade students.

Rational Numbers

1. The student knows that a rational number is any number that can be named in the form a/b, $b \neq 0$, when a and b are integers.
2. The student knows that the set of whole numbers and the set of integers are subsets of the set of rational numbers.

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[1] Course Goals in Mathematics, K-12, (Portland, Oregon: Tri-County Development Project, 1974, pp.21-28.

3. The student knows that any integer can be expressed in rational form a/b with b = 1.

4. The student knows the three common forms of rational numbers are fraction, decimal fraction (decimal) and percent.

5. The student knows the definition of key terms associated with rational numbers, including rational number, fraction, numerator, denominator, proper, improper, mixed numerals, repeating decimals, and decimal fractions.

6. The student knows that the properties, definitions, and computation facts valid for the set of integers are valid for the set of rational numbers.

7. The student knows that the set of rational numbers is dense since between any two rational numbers there is another rational number.

8. The student knows the multiplicative inverse of a nonzero number b is 1/b and that b.1/b = 1.

9. The student knows that the multiplicative inverse (reciprocal) is defined for every rational number except zero.

10. The student knows the identity elements for addition (zero, 0) and multiplication (one, 1) in the set of rational numbers.

11. The student knows that in the set of rational numbers the product of two numbers is zero if and only if one or both is zero.

12. The student knows that the set of rational numbers corresponds to points on a number line.

13. The student is able to locate the set of rational numbers on a number line.

14. The student is able to represent mathematical operations with rational numbers on a number line.

15. The student knows that a number written in the form a/b with $b \neq 0$ is in fractional form.

16. The student knows that a numeral in the form a/b represents the quotient of a divided by b. (e.g.,3/4 = 3 ÷ 4).

17. The student knows that a fractional number has an infinite set of equivalent fraction names (1/2 = 2/4 = 3/6 = 4/8...).

18. The student knows equivalent fractions may be produced by multiplying by an appropriate form of one.

19. The student is able to express a rational number greater than one as an improper fraction or a mixed numeral.

20. The student knows that in a decimal fraction the decimal point separates the fractional number from the whole number.

21. The student knows the place value represented by each digit in a decimal fraction.

22. The student is able to express a decimal numeral in expanded notation, (e.g. 7.125 = 7/1 + 1/10 + 2/100 + 5/1000).

23. The student knows the forms of a decimal fraction (terminating and nonterminating, repeating and nonrepeating).

24. The student knows that any repeating or terminating decimal represents a rational number.

25. The student knows a method to write any rational number in either fractional or decimal form.

26. The student knows the equivalent forms of commonly used rational numbers, (1/4 = .25 = 25%, 1/10 = .1 = 10%).

27. The student is able to perform the fundamental operations on rational numbers, including fractions and decimal numerals.

Addition

28. The student knows that in the set of rational numbers addition is closed, commutative and associative.

29. The student is able to find a common denominator (multiple) for two or more rational numbers in fractional form.

30. The student is able to rename fractions with different denominators as fractions with the same denominator.

31. The student knows that the sum of two fractions with the same denominator is the sum of the numerators divided by that denominator (i.e., $a/b + c/b = \frac{a + c}{b}$).

32. The student is able to add rational numbers in fractional form (includig fractions and mixed numbers with the same or different denominators).

33. The student knows the rules for addition of rational decimal fractions (including additions of equal place values and placement of the decimal point).

34. The student is able to add rational decimal fractions.

Subtraction

35. The student knows that the set of rational numbers is closed for subtraction.

36. The student knows that subtraction in the set of rational numbers is not commutative or associative.

37. The student knows the rules for addition of rational numbers that apply to subtraction in the set of rational numbers (including the inverse nature of the operations, place value rules, regrouping or borrowing, placement of the decimal point, and the common denominator properties).

38. The student is able to subtract rational numbers (including fractions and decimals).

Multiplication

39. The student knows that the product of two rational numbers is the product of the numerators divided by the product of the denominators (i.e., for rational numbers a/b and c/d, a/b.c/d = ac/bd).

40. The student knows that in the set of rational numbers multiplication is closed, commutative, associative, and distributes over addition.

41. The student knows that factors in mixed numeral form can be renamed as improper fractions.

42. The student knows that the product of two fractions is a fraction a/b where a is the product of the numerators and b the product of the denominators.

43. The student is able to multiply rational numbers in fractional form (including fractions and mixed numerals).

44. The student knows the rules for multiplication of rational decimal fractions (including place of the decimal point, regrouping or carrying and place value rules).

45. The student is able to multiply rational decimal fractions.

Division

46. The student knows that in the set of rational numbers division may be defined as multiplicative inverse (reciprocal) (i.e., a/b = a. 1/b).

47. The student knows that every rational number except zero has a multiplicative inverse.

48. The student knows that division in the set of rational numbers is closed except for division by zero which is undefined.

49. The student knows that in the set of rational numbers division is not commutative or associative.

50. The student knows the properties of multiplication of fractions that apply to division of fractions (including the inverse nature of the operations and the use of improper fractions to replace mixed numerals).

51. The student knows the rules for division of rational decimal fractions (including placement of the decimal point and place value rules).

52. The student is able to divide rational numbers (including fractions and decimals).

Language Arts Competencies

These language arts competencies have been taken in total from the Language Arts Curriculum Guide for K-6 Classrooms published by the Joint School District No. 1 of Fond Du Lac, Wisconsin.[2]

Listening Skills

LA 1. Show that you can follow oral directions.

LA 2. Show that you can remember specific information from an oral presentation.

LA 3. Show your understanding of information presented orally by summarizing and interpreting the content.

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[2] Language Arts Curriculum Guide for K-6 Classrooms, (Fond Du Lac, Wisconsin Joint School District No.1,1972),p.vi.

LA 4. Evaluate techniques used by the speaker in an oral presentation.

Speaking Skills

LA 5. Show that you can present descriptions of personal experiences and other ideas effectively to an audience.

LA 6. Show that you can plan and conduct personal interviews.

LA 7. Show that you can use techniques for preparing an organized oral report.

LA 8. Show that you can present an organized oral report.

LA 9. Show that you can participate in achieving the goals of a discussion group.

LA 10. Show that you can apply techniques for leading a discussion.

Reading Skills

LA 11. Show that you know how to follow a left-to-right sequence.

LA 12. Show that you know the letters of the alphabet.

LA 13. Show your understanding of the similarities and differences among sounds.

LA 14. Show your understanding of similarities and differences among visual symbols.

LA 15. Show that you can follow written and oral directions.

LA 16. Show that you can apply various techniques for reading new words independently.

LA 17. Show your understanding of a literary selection by reading with 75 percent to 90 percent comprehension.

LA 18. Show that you can use structural analysis to recognize and use the correct forms of words.

LA 19. Show your understanding of the structure and meaning of words and phrases by relating them to contextual uses.

LA 20. Show that you can apply skills of phonetic and structural analysis to improve your spelling and reading.

Writing Skills

LA 21. Show that you can make visually distinct patterns.

LA 22. Show your understanding of common nouns, proper nouns, and pronouns in sentences.

LA 23. Show that you can recognize and use correct verb forms in sentences.

LA 24. Show that you can correctly apply the following: period, question mark, capital letters, quotation marks, comma, exclamation mark, and indentation.

LA 25. Show that you can use descriptive words or phrases.

LA 26. Demonstrate your ability to combine concepts, principles, and generalizations by writing original stories, reports, and poems.

LA 27. Demonstrate your ability to combine concepts, principles, and generalizations by organizing sentences and paragraphs to develop a topic.

LA 28. Show that you can write sentences using various types of sentence structure.

LA 29. Demonstrate your ability to combine concepts, principles, and generalizationss by producing a simple newspaper (no less than one page) that includes one article of class (local) interest, one article of school (national) interest, one article of community (world) interest, and one article from each of the following sections: classified, sports, theater-entertainment, editorial, and comics.

Study Skills

LA 30. Show that you can select reading material suitable to your reading level.

LA 31. Show that you can apply effective note-taking techniques (includes outlining).

LA 32. Show that you can recognize and/or use all parts of a book.

LA 33. Show that you can use a dictionary to locate words and to identify the structure, meaning, spelling, and pronunciation.

LA 34. Show that you can use a card catalogue to find information in the library.

LA 35. Show that you can use encyclopedias and other references to find information.

Personal Communication and Development Skills

LA 36. Show that you can use the telephone.

LA 37. Show your understanding of appropriate forms of conversations.

LA 38. Show that you can write friendly and business letters using the correct format.

LA 39. Show that you can use skills of nonverbal communication.

Literary Analysis Skills

LA 40. Show your understanding of fact and fantasy in literature and media.

LA 41. Show your understanding of the personality traits of literary characters.

LA 42. Show your understanding of literary selections by making inferences based on details.

LA 43. Show your understanding of the setting and plot development in literary selections.

LA 44. Demonstrate your ability to perceive the author's intent and/or point of view in literary selections.

Social Studies Competencies

The purpose of the social studies aspect of this core curriculum was to interrelate in as many ways as possible necessary mathematics ideas with historical situations, ideas of good citizenship, and the use of a newspaper. To this end, the use of several sources was found necessary. These sources were (1) the Culpeper County Public Schools Social Studies/Citizenship Competencies Program K-12, (2) 492 Ways to Use a Newspaper in the Elementary Classroom published by the Montgomery County Public Schools, (3) Mathematical Nuggets from the Newspaper by Buzitis and

Keller, (4) Famous Black Americans Number Puzzles by Ecklund, and (5) Famous Places and Events by Silvani. This writer also believed in the use of word problems, sometimes known as story problems, to provide social studies information along with operational decision-making. To this end, the method of generating specific types of story problems was included in this paper. Also included were objectives from An Integrated Approach to Black History, a curriculum written by Taylor and Anderson and objectives from Howard County's African Studies unit. To eliminate later notational problems, all social studies competencies were started with the letters "SS-" to be followed by "C" for citizenship, "H" for history, "N" for newspaper, "NP" for number puzzles, "SP" for story problem, and "AS" for African Studies. These sources were further elaborated over the next few pages.

Culpeper County Public Schools Social Studies Citizenship Competencies Program K - 12 (SS - C).

The following competencies are the exact fifth grade competencies for the Culpeper County School System and not the general K-12 competencies which vary slightly from one grade to another.

SS-C 1. The student shall place in order the following events in American history:

a. The discovery of America by Columbus
b. Thanksgiving
c. Independence
d. Washington's or Lincoln's presidency
e. Settlement of Jamestown
f. Williamsburg as colonial capital
g. The Revolution
h. Westward expansion
i. Civil War

SS-C 2. Given the person's name or accomplishment, the student should be able to supply the other:

a. Columbus
b. Abraham Lincoln
c. John Smith
d. George Washington
e. Thomas Jefferson
f. Benjamin Franklin
g. Patrick Henry
h. Robert E. Lee
i. Harriet Beecher Stowe

SS-C 3. The student will be able to tell the purpose of the Constitution, Declaration of Independence, Articles of Confederation and Bill of Rights.

SS-C 4. The student will be able to give an example (list and explain) of the Constitutional guarantees of all United States citizens:

a. Freedom of religion,speech,press,petitions
b. Right to keep weapons
c. Right to private home
d. Limits of government search,taking of property
e. Rights of persons accused of crime
f. Right to a fair trial
g. Right to a jury trial
h. Limits on fines and punishment

The student shall have an understanding of the Pledge of Allegiance.

SS-C 5. The student will be able to identify proper procedures for dealing with misbehavior in the school.

SS-C 6. The student shall be able to use, identify, or locate:

a. The four directions
b. A map key
c. A county
d. A state
e. A country
f. A continent

SS-C 7. The student will be able to define the senate, house of representatives, and President.

The student will be able to define one specific duty performed by Congress and one specific duty performed by the President.

SS-C 8. The student will be able to define the single major duty of each:

a. Executive branch
b. Legislative branch
c. Judicial branch

SS-C 9. The student will be able to explain how voting in national elections can influence natioanl government.

SS-C 10. The student will be able to recognize his responsibility as a citizen on national current issues.

SS-C 11. The student will be able to understand how specializing goods and services created the expansion of trade between the colonies.

In the Culpeper social studies curriculum guide, competency 12 is not stressed at the fifth grade level and as such, it is not here mentioned.

SS-C 13. The student will be able to identify:

a. An atlas
b. Graphs and tables
c. The north and south hemispheres
d. The equator
e. A lake

SS-C 14. The student will be able to identify a card catalog, fiction from non-fiction, and be able to use specific references found in the school library.

SS-C 15. The student will be able to correctly identify statements of fact from statements of opinions.

SS-C 16. The student will be able to show one cultural relationship between the United States and Latin America and also between the United States and Canada.

Social Studies - History - (SS-H)

In the relationship of history to mathematics, this writer believed that a presentation of the historical development of the particular math subject would suffice. Four books have been presented which could be used by the

students. Two of the books have sections dealing with arithmetics, algebra, and geometry. These books are: A Survey of Mathematics: Elementary Concepts and Their Historical Development by Virginia Shaw Groza and The Historical Roots of Elementary Mathematics by Bunt, Jones and Bedient. Both books have good pictures and exercises at the end of each chapter. Both books also give answers to selected problem exercises.

David Smith's Number Stories of Long Ago also has good pictures, problem exercises and their answers, but Smith's book deals only with arithmetics. It must be said that Smith's book borders on very good children's literature. Karpinski's book The History of Arithmetic is an excellent work. Its major drawback is that it does not offer problems for students, but it does have very good pictures and even discusses the various historical ways of teaching arithmetic.

With the teacher's help, the students might find Ball's A Short Account of the History of Mathematics quite interesting. It deals much more thoroughly with the times in which the mathematics were developed. It also gives narratives of the lives of the mathematicians. There are a few diagrams, no pictures of the mathematicians, and no study questions or problems.

It should be remembered that the intention of the history section is the exposure of the student to the mathematics through its historical development. It is from this vantage point that further exploration into history or ethnology may be launched.

Social Studies - The Newspaper (SS-N)

It is the belief of this author that the use of a newspaper is indispensable for the type of core curriculum which chooses a specific subject through which to study other areas of the curriculum. This is because a newspaper regularly publishes articles involving science, social studies, math and language arts skills and competencies. Buzitis and Keller stated as their rationale for using a newspaper in the teaching of mathematics the following.[3]

> ...it is our responsibility to prepare children for the kind of world they will live in, and to prepare them to perform the kind of skills they will need in the day-to-day living; it is essential that we give real-life situations in which to practice their textbook skills. The newspaper is an excellent vehicle or tool for bringing real-life problems to young people and it is one of the few tools they will continue to use as adults.

The following objectives have been taken from Buzitis and Keller's book, page i.

SS-N 1. To develop the ability to use fundamental computational processes in everyday problem-solving situations found in newspapers.

SS-N 2. To provide meaningful and exciting learning experiences using the newspaper.

SS-N 3. To develop a real and lasting interest in using and reading the newspaper which will become a lifetime habit.

SS-N 4. To provide a model emphasizing mathematics as a necessary skill used in a wide range of everyday activities, rather than an isolated discipline.

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[3]Betty Buzitis and Jeanette Keller, Mathematical Nuggets from the Newspaper, (Fresno, California: Creative Teaching Associates, 1977), p.i.

SS-N 5. To foster the ability [illegible]ink of creative applications of numbers in rela[illegible]ion to everyday mathematical situations.

Social Studies - Number Puzzles (SS - NP)

Number puzzles have been made a part of this curriculum because they have a heavy emphasis on computation and at the same time provide information in another area of the curriculum. The creative teacher can make his own number puzzles or he can show the class how to make them and thereby generate through the spirit master process or mimeograph process a high quantity and variety of math core worksheets. A description of number puzzles follows and is given for the persons unfamiliar with them.

A number puzzle is a worksheet that is broken into two parts. The bottom part of the sheet consists of up to 26 computation problems each of which is assigned a letter of the alphabet. The top part of the sheet consists of short lines drawn on the page beneath which are the answers to the computation problems. When the student has answered the computation problems, he then can look in the top part of his sheet to find an answer identical to his. If he finds such an answer, he places the letter assigned to the problem that he just solved on the blank line above the answer and then continues to match his answers with those on the worksheet. At the end of all this, the student has either a phrase or a few sentences pertinent to an area of study outside of mathematics. Examples of number puzzles have been reproduced for the reader's benefit. The first is puzzle number 22

from Ecklund's Famous Black Americans Number Puzzles Book C[4] and the second is from Silvani's Famous Places and Events.[5] It is puzzle number 27.

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[4]Larry Ecklund. Famous Black Americans Number Puzzles Book C. (Fresno, California: Creative Teaching Associates, 1976), Puzzle No. 22.

[5]Harold Silvani. Famous Places and Events. (Fresno, California: Creative Teaching Associates, 1976), Puzzle No. 27.

Puzzle 22

When this famous American started to play ball with the Cleveland Indians, he had already pitched, and won, more games than anyone in baseball history. He had been barred from the major leagues because of his race. When he joined the Indians, he had already pitched for over 20 years.

2	$7\frac{1}{2}$	$3\frac{3}{16}$	$\frac{5}{6}$	12

" "

$8\frac{3}{4}$	$\frac{1}{3}$	$16\frac{7}{8}$	$\frac{3}{16}$	9	$7\frac{1}{2}$	2	$1\frac{5}{9}$	$\frac{1}{3}$	$\frac{1}{2}$	$1\frac{4}{5}$	$7\frac{1}{2}$

Complete the problems below. Express answers in simplified form. Use the code letters above each problem to find the name of this famous person.

A. $\frac{2}{3} \times \frac{1}{2} =$

C. $\frac{1}{4} \times \frac{3}{4} =$

D. $\frac{2}{4} \times \frac{1}{2} =$

E. $\frac{9}{3} \times \frac{5}{2} =$

G. $\frac{12}{4} \times \frac{3}{5} =$

H. $\frac{15}{5} \times \frac{12}{4} =$

I. $2 \times \frac{1}{4} =$

L. $\frac{1}{3} \times 6 =$

M. $\frac{1}{4} \times 4 =$

O. $2\frac{1}{2} \times \frac{1}{3} =$

P. $\frac{2}{3} \times 2\frac{1}{3} =$

R. $\frac{3}{4} \times 4\frac{1}{4} =$

S. $3\frac{1}{2} \times 2\frac{1}{2} =$

T. $4\frac{1}{2} \times 3\frac{3}{4} =$

Y. $2\frac{1}{4} \times 5\frac{1}{3} =$

Creative Teaching Associates

Puzzle #27

IN 1861 AFTER THE ____ ____ ____ ____ ____ ____ ____ ____ HAD STARTED,

____ ____ ____ ____ ____ ____ ____ ____ ____

____ ____ ____ ____ VISITED ____ ____ ____ ____ ____ ____ ____ ____

CAMPS NEAR ____ ____ ____ ____ ____ ____ ____ ____ ____ ____.

____ ____. SHE WAS INSPIRED TO WRITE THE WORDS TO THE "____ ____ ____.

____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

____ ____ ____ ____ ____ ____ ____ ____" TO THE TUNE OF

"____ ____ ____ ____ ____ ____ ____ ____ ____ ____.

____ ____ ____ ____." IT BECAME THE MAJOR WAR ____ ____ ____ ____

OF THE ARMED FORCES. SHE WAS BORN ON ____ ____ ____ 27, 1819.

A.	B.	C.	D.	E.	F.
$\frac{3}{7} + \frac{1}{2} =$	$2\frac{3}{4} \times 1\frac{1}{3} =$	$\frac{3}{8} \div \frac{6}{6} =$	$2\frac{5}{6} \times 2\frac{1}{3} =$	$\frac{7}{10} \div \frac{2}{3} =$	$6\frac{1}{2} \times 3\frac{1}{3} =$
G.	**H.**	**I.**	**J.**	**K.**	**L.**
$\frac{5}{6} \div \frac{2}{3} =$	$7\frac{1}{2} \times 2\frac{3}{4} =$	$\frac{2}{3} \div \frac{5}{11} =$	$5\frac{2}{3} \times 2\frac{1}{2} = 14\frac{1}{6}$	$\frac{3}{4} \div \frac{3}{4} =$	$1\frac{3}{8} \times 4\frac{1}{2} =$
M.	**N.**	**O.**	**P.**	**R.**	**S.**
$3\frac{1}{3} \div 1\frac{3}{4} =$	$4\frac{2}{3} \times 3\frac{1}{2} =$	$1\frac{2}{7} \div 4\frac{1}{3} =$	$2\frac{2}{5} \times 3\frac{1}{4} =$	$3\frac{2}{5} \times 1\frac{2}{3}$	$5\frac{3}{4} - 3\frac{3}{4} =$
T.	**U.**	**V.**	**W.**	**X.**	**Y.**
$2\frac{1}{2} \div 3\frac{2}{3} =$	$2\frac{3}{5} \times 3\frac{2}{5} =$	$2\frac{7}{9} \div 2\frac{3}{4} =$	$2\frac{4}{5} \times 1\frac{4}{7} =$	$1\frac{1}{3} \div \frac{2}{9} =$	$5\frac{3}{4} \times 2\frac{5}{6}$

Social Studies - Story Problems (SS - SP)

The use of story problems as a way of interrelating mathematics and another subject was not demonstrated in an investigation of the literature for the preparation of this paper. It seemed as though this was an extremely important area to develop in that the proportion of real life situations involving a choice of the proper arithmetic operation was far greater than those that required computation, particularly computation without the aid of some sort of calculator. This writer believed that once the various methods for the generation of word problems (story problems) was understood, the teacher could easily generate hundreds of mathematics word problems using scientific, literary, or social studies facts. It was also hoped that with time and understanding, the students would generate their own word problems which the teacher could collect,type, duplicate, and redistribute to the class.

The following types of word problems were discussed by Ethel Sutherland in her book entitled One Step Problem Patterns and Their Relation to Problem Solving in Arithmetic. This author believed that a reproduction of the relevant parts of the book plus the addition of examples of the problem patterns were necessary to the understanding of the use of word problems in math core curricula. The reader should remember that in teaching how to solve story problems, Sutherland is stressing a recognition of the operational ideas within the story problem and is not focusing on a word-action method for solving the problems.

Sutherland identifies 38 thought pattern variations students should be able to recognize when engaging in one-step verbal arithmetic problems. These patterns are given below along with the variations on the patterns (it is these variations that actually make for the 38 patterns). Also given are Sutherland's explanations of the variations with examples of them.

Sutherland has identified four major subtraction patterns. These patterns utilize (1) the remainder or how much left idea; (2) the how much more or building up idea; (3) the comparison or difference idea; and (4) the separation into parts idea.

Sutherland attributes the differences in the patterns to differences in the underlying thought behind the patterns.[6] The variations within the pattern are attributed to the technical phraseology of that variation.[7] The following patterns have been presented along with their variations for the reader's benefit and understanding. For notational purposes, these thought patterns include an extra letter to denote the operation of which they speak.

Patterns That Involve The Remainder or

"How Much Left Idea"

SS-SP S1. Given: An amount has been decreased.

Find: How much is left or remains.

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[6] Mary Sutherland, One Step Problem Patterns and Their Relation to Problem Solving in Arithmetic, (New York: AMS Press, 1947), p. 13.

[7] Ibid.

The notion of a decrease may be suggested by a wide variety of words such as spend, sell, give, take, lose, fly away, run away, break, etc. "How many are left?" or "How many remain?" are questions characteristic of this pattern variation. The following problem illustrates this variation.

Mack saved 70¢. He bought a ball for 45¢. How much money does he have left?

SS-SP S2. Given: An amount of money has been decreased by a purchase.

Find: The amount of change received. "How much was received?" is the question characteristic of this pattern variation.

Mike paid $.56 for a book. He gave the clerk $1.00. How much change should he get back?

SS-SP S3. Given: An amount has been decreased. The amount left or the change received is known.

Find: The amount taken away, spent, sold, given away, etc.

This is the inverse of variations S1 and S2. In this variation a given amount is decreased but one finds the amount taken away instead of the amount left. Sutherland says that the student should "work backwards"[8] in order to find the amount spent, given away, eaten, sold, etc.

When Jane bought a dress, she gave the clerk $20.00 and he gave her $7.00 in change. How much

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[8] Ibid., p. 14

did Jane's dress cost?

Willie bought 12 peaches yesterday. Today all but four have been eaten. How many peaches were eaten?

The second pattern is exemplified in one manner.

The Pattern That Involves the "How Much More" or Building-Up Idea

SS-SP S4. Given: An amount is on hand and a given larger amount is desired.

Find: How much more is needed to equal the desired larger amount.

Elizabeth wants to color 15 eggs for Easter. She has already colored 6. How many does she still need to color?

Ricky wants to buy a record album for $4.30. He has $2.58 in his bank. How much more money does he need to buy the record?

The Pattern That Involves the Comparison or Difference Idea

SS-SP S5. Given: Two unequal amounts. They are to be compared.

Find: How much more or how much less one is than the other.

The characteristic expressions are "How much more than," and "How much less than."

Johnny made 14 bars of soap in class and Marty made 8 bars of soap. How many more bars of soap did Johnny make than Marty?

Bill weighs 65 pounds. Dorothy weighs 78 pounds.

Bill weighs____pounds less than Dorothy.

SS-SP S6. Given: Two unequal amounts to be compared.

Find: How much larger, longer, taller, older, shorter, wider, etc. one is than the other.

Characteristic expressions of this variation are "How much older," "How much shorter," etc.

Bill is 10 years old. His father is 63 years old. How many years older than Bill is his father?

The temperature was 63 degrees this morning. This evening the temperature was 57 degrees. How many degrees cooler was it this evening compared to this morning?

SS-SP S7. Given: Two unequal amounts to be compared.

Find: Their difference.

Expressions characteristic of this variation are "Difference in" and "Difference between."

Tim paid $1.25 for a movie ticket. Joe paid $2.75 for his ticket. What is the difference between the prices of these tickets?

Azira is 9 years old. Her mother is 31 years old. What is the difference between their ages?

SS-SP S8. Given: Two unequal amounts are to be compared.

Find: Their difference. The word difference is not used in the problem.[9]

According to Sutherland, there are no technical

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[9]Ibid., p. 16.

expressions that are characteristic of problems of this variation, but that the difference will represent some sort of gain or loss usually.

Alice weighed 39 pounds last year. This year she weighs 56 poumds. How many pounds has she gained?

The mileage gauge on your father's car reads that 879.6 miles were driven by the end of Friday. By the end of Sunday, the mileage gauge read 1173.2 miles driven. How many miles did your father drive between the end of Friday and the end of Sunday?

SS-SP S9. Given: Two unequal amounts have been compared. One of the amounts and the difference between it and the other amount are given.

Find: The other amount.

A comparison has already been made between two numbers. The difference of these two numbers must be found. Sutherland says that a child should work backwards in order to solve this type of problem.[10]

Alice has 10 jacks. Grace says, "Alice has 2 more jacks than I have." How many jacks does Grace have?

Abraham Lincoln died in 1865. He was 56 years old when he died. In what year was he born?

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[10]Ibid., p. 17

The Pattern That Involves the Separation Into Parts Idea

SS-SP S10. Given: The sum and one part.

Find: The other part.

"In this pattern, there is no decrease of a given amount, no finding the amount left, and no comparison. The concern is merely to find one part when the sum and the other part are given."[11]

Omar has 245 goats. He has 186 brown goats. The rest of the goats are black. How many black goats does Omar have?

The school nurse weighed 845 children. Of this number 269 were overweight. How many children were not overweight?

The Meaning of Substraction for Sutherland

Sutherland believes that each one-step problem belonging to any of the above variations of the four thought patterns contributes to the formulation of a generalization about that pattern. As such, each pattern contributes to the formulation of a generalization regarding the process of subtraction.[12]

For Sutherland subtraction means a process which is used when (1) a given amount has been decreased and the amount left is required; (2) a given amount is on hand and it is

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[11] Ibid., p. 17.

[12] Ibid., p. 18.

required to find out how much more is needed to equal a desired total amount; (3) two numbers are to be compared by finding their differences; and (4) when the whole and one part are given and it is necessary to find the other part.[13]

Sutherland divided the word problems dealing with division into two types, those dealing with the obtainment of the size of the members of a group, the partition concept of division; and those dealing with the obtainment of the number of groups, the measurement concept of division.[14] She also found that each of the above mentioned types had eight variations which could be separated into three classes: (1) the simpler variations requiring that a number of groups be formed; (2) the variations involving concepts of distance, rate, and time; and (3) the patterns involving the comparison of the two numbers. These three types all pertain to the measurement concept of division. The partition concept also may be divided into three groups: (1) those variations involving the finding of the amount, size, or cost of each part; (2) those variations involving the concept of an average not related to distance, rate, and time; and (3) those variations involving concepts of an average in relation to distance, rate, and time. The above categories, subcategories, and variations were investigated with regard to determining what concepts of the operation of division facilitate a correct

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[13] Ibid.

[14] Ibid., p.48.

choice of that operation in one-step division word problems.

Word Problems Representing the Measurement Concept of Division.

I. Simpler variations requiring a number of groups to be formed.

SS-SP D1. Given: A total number of like units and the number of units in each group.

Find: The number of groups that can be formed.

Two hundred-fifteen popsicle sticks were needed for the third grade art project. If each child in the third grade brought 5 popsicle sticks, how many children were needed to bring 215 popsicle sticks?

SS-SP D2. Given: The total cost or amount and the cost or amount of one unit.

Find: The number of units purchased or required. The word amount as used in this pattern refers wholly to money.

Tom had $.30 to spend on stamps. If one stamp costs $.05, how many stamps can he get for $.30?

SS-SP D3. Given: The total amount to be paid, saved or done and the rate of doing it.

Find: The total time needed.

Bill wants a calculator priced at $10.50. He can save $.50 a week. How many weeks will it take before he can pay for the calculator?

The thought behind each of the above variations is that of finding the number of groups that can be formed when the

total number of like units in a group are given. The difference between the variations lies in whether an answer will be given in terms of money or time. Variation D1 may include every type of unit except money whereas D2 deals only with money and D3 deals with rate problems where the answer is given in terms of time.

The second group of variations deals with distance, rate, and time and are usually called motion problems.

II. Variations involving distance, rate, time.

SS-SP D4. Given: Total distance and rate per unit time.
Find: Time.
The technical expressions characteristic of this variation are "at the rate," "average speed," "averages so many units an hour."
If a car travels at 60 miles per hour, how long will it take the car to go 180 miles?

SS-SP D5. Given: Total distance and distance covered per gallon.
Find: Number of gallons.
"Miles per gallon," "at the rate," "averages so many miles on one gallon" are technical expressions often found accompanying this variation.
Mike's car uses a gallon of gasoline every 21 miles. How many gallons will the car use on a trip of 672 miles?

SS-SP D6. Given: Total time and time per unit of distance.
Find: Total distance.

Timbe rode her bike a mile in 5 minutes. At that rate, how far would she ride in 45 minutes?

In the problems mentioned above, the underlying thought is one of measuring. For instance, how many times the distance traveled in one day or one hour is contained in the total distance?

Example D5 represents the number of times the distance traveled on a gallon of gas is contained in the total distance. Example D6 represents how many times the time to travel a mile is contained in the total time traveled.

The third group of variations representing the measurement concept of division involves the comparison of two numbers.

III. The Comparison of Two Numbers.

SS-SP D7. Given: Two numbers.

Find: How many times one number is larger than the other.

The expressions which occur frequently in problems of this nature are "How many times as large," "How many times as many," "How many times as high," etc.

Bob is 9 years old. His father is 45 years old. How many times Bob's age is his father's age?

SS-SP D8. Given: Two numbers.

Find: What part of the larger number is the small number.

The Bullets won 85 out of 95 games. What part of

the games played were won?

Sutherland offers no explanation for example D8[15] except to say that the one thing that all the examples have in common is that they all determine how many groups of a given size can be formed from a given number which is the measurement concept of division.

Word Problems Representing the Partitive Concept of Division

IV. Finding the amount, size, or cost of each part.

SS-SP D9. Given: Total Number and a fraction.

Find: A fractional part of the total number. In this variation the numerator is one.

In Sutherland's study the numerator for this variation was one. She also said that this was a division pattern for grades three and four.

Will has 106 baseball cards. One-half were sold to Liza. How many baseball cards does Liza have?

SS-SP D10. Given: Total amount and the number of parts[16] into which the total is to be divided.

Find: The number or size of each part.[17]

Juana has a rope that is 260 feet long. She wants to cut it into 4 pieces so that each piece will be the same length. How long will each piece be?

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[15] Ibid., p. 68.

[16] Dr. Sutherland means the number of groupings.

[17] Dr. Sutherland means that the number or size of the members of a group should be found.

SS-SP D11. Given: Total amount and the number of persons involved.

Find: The equal share per person.

The expressions representing this thought pattern variation are "divide equally,"share equally," and "how much is each person's share."

Lonnie has 355 marbles. He divides them equally among 5 friends. How many marbles does each friend get?

SS-SP D12. Given: Total cost and the number of like articles purchased.

Find: Cost of one article.

D12 always deals with the total cost, the number of like articles purchased, and the cost of one article.

Ifetayo paid $1.17 for 9 peaches. How much did each peach cost?

What is characteristic of variations D9 through D12 is that each requires finding the amount, size, or cost of each member of a group when the total number and the number of groups are given. Sutherland notes that in thought pattern variation D9 a student is taught that in order to take 1/2, 1/3, 1/4 etc. of a number, that number can be divided by 2, 3, 4 etc. and that it is later[18] in the academic development of the student that this problem would be handled as a

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[18]Ibid., p. 20.

multiplication problem. In variations D10, D11, and D12, the fractional part of the number which is to be found is not given as a fraction, but as a whole number.

The next pattern pertaining to the partition concept involves the concept of an average and has one examplar. When the average is used in this variation, concepts pertaining to distance are neglected. They appear under variations D14, D15, and D16.

V. The Partitive Concept of Division and the Concept of the Average.

SS-SP D13. Given: Total amount and the number of units involved.

Find: The average per unit.

"Average amount," "average price," "average cost," "average rainfall," "average yield," etc. are expressions found often in connection with this thought pattern. Sometimes the word average is not used but is implied, as in example number two.

Bill's food bill for the month of April is $120.00. His is an average of____dollars a day.

JoAnne did 12 homework problems in 132 minutes. At this rate[19] how long did it take to do one homework problem?

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[19]Sutherland does not say if this example has overt characteristics in common with other word problems dealing with the partitive meaning of division and containing the concept of the average without using the word.

VI. Thought Pattern Variations Involving Concepts of Average in Relation to Distance, Rate, and Time.

SS-SP D14. Given: Total distance and time.

Find: Rate per unit of time.

The technical expressions which reflect this thought pattern variation are "miles per hour," "average speed per hour," "average rate," etc. In some problems of this type, an average is implied but the word is not used.[20]

An airplane travels 1233 miles in 3 hours. Find the average speed of the plane per hour.

SS-SP D15. Given: Total distance and number of gallons.

Find: Distance per gallon.

The common technical expressions found in this type of variation are "miles per gallon," "average number of miles per gallon," and "average per gallon."

Jay drove 575 miles on 25 gallons of gas. How many miles did the car go on one gallon of gas?

Tungi drove his car 432 miles on 9 gallons of gas. How many miles per gallon did he average?

SS-SP D16. Given: Total time and total distance.

Find: Time per unit distance.

Kirk went on a 4 mile hike. He covered this distance in 48 minutes. How long did it take him to walk one mile?

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[20] Sutherland means distance per unit time.

Variations D14, D15, and D16 are believed by Sutherland to be the most difficult for students to grasp because they combine the concept of the average along with concepts of distance, time, and rate to produce a partitive meaning of division. She notes though, that these concepts must be mastered in order to be successful with these types of problems. She also notes that all problems illustrating the eight variations in the partitive thought pattern are similar in that they involve the separation of a number into equal groups and that this separation may require finding the size of each group, finding the cost of one member of a group (as in D12), finding the share of each person in a group, finding the average cost, yield, or amount per unit, finding the rate traveled per unit time, the distance per gallon, or the time to travel one unit of distance, and that in each case, the problem is concerned with the number or amount of each group and that this is found by division.[21]

Sutherland believes that each of the variations presented so far is representative of a thought pattern and that the generalization of these variations leads to a generalization of these patterns which in turn leads to generalizations concerning the process of division. It is through these generalizations that division comes to mean the process which is used to find the number of groups of a given size that can be formed from a given number and also the process

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[21] Ibid., p. 70.

by which the number of members of a group can be found when the number of equal groups is given. It is believed that these meanings of division are incorporated by the student only after wide experience with the problems in each variation and the recognition of the commonalities among the various division thought patterns.[22]

Sutherland notes eight variations of two thought patterns concerning multiplication. The two thought patterns are (1) those patterns requiring the total amount to be found when the amount in one group and the number of groups are given; and (2), those patterns that deal with finding a fractional part of a number. The reader should understand that in regard to the number of thought patterns, Sutherland begins this section by stating that there are five thought patterns but ends this section stating that all eight variations can be grouped into two "notions" concerning multiplication.[23] It is these two notions that I have taken to be Sutherland's basic "thought patterns," i.e., her basic concepts concerning the meaning of multiplication. Sutherland also chooses not to group together those variations pertinent to the first meaning of multiplication (the total amount to be found meaning).[24] I have tried to avoid this confusion by grouping all these variations together and renumbering them.

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[22] Ibid.

[23] Ibid., p. 89-94.

[24] Ibid., p. 94.

As such, variations M5, M6, M7, and M8 in this paper correspond respectively to Sutherland's variations M8, M5, M6 and M7.

Thought Pattern Variations Requiring the Total Amount to Be Found

SS-SP M1. Given: The number or amount in one group and the number of groups.

Find: The total number or amount.

The characteristic expressions are "in all," "both," "all together," "twice as much," "two times as many," etc. These expressions help emphasize the fact that the total must be found.

Kwaku has 9 bags of marbles. He has 112 marbles in each bag. How many marbles has Kwaku got all together?

Tawana has a cake recipe which calls for 3/4 cup of milk. She wants to make 3 times as much cake as the recipe provides. How much milk should she use?

SS-SP M2. Given: The cost or amount of one unit and the number of units.

Find: The total cost or amount of money.

The words characteristic of this variation are "cost," "charge," "pay," "spend," "earn," etc. Also, "in all," "both," "all together," "twice as many," etc. may also appear.

Damnni bought 9 tickets for the carnival. Each ticket cost $.75. How much money did he spend

for all the tickets?

Sutherland believes that the underlying thought in each of these two patterns is that of finding the total number or amount when the number or amount in one group and the number of groups are given.[25] Pattern variation M1 includes all the examples which would not fall into pattern variation M2 which deals with finding the total cost or the total amount of money.

SS-SP M3. Given: Rate per unit time[26] and the time.

Find: Total distance.

Expressions often found in problems of this type are "at the rate," "average & speed," "averages so many miles per hour."

At 4 miles per hour, how far can you walk in three hours?

How far will an airplane fly in 3¼ hours if its average speed is 255 miles an hour?

SS-SP M4. Given: Mileage per gallon & number of gallons.

Find: Total distance.

Characteristic expressions for this variation are "miles per gallon," "at the rate," "averages so many units on one gallon."

Our automobile can travel 16.5 miles on one gallon of gas. At that rate, how far can it go on 15 gallons of gas?

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[25] Ibid., p. 90.

[26] Sutherland means distance per unit of time.

SS-SP M5. Given: One part of a number.

Find: The total number.

Karen paid 35 cents for ¼ lb. of butter. At this rate, how much would one pound of butter cost?

Again in M3, M4, and M5, the basic idea is finding the total amount but the concepts involved in finding the answer are a little harder than they were in M1 and M2.

The Pattern Variation Requiring That A Fractional Part of a Number Be Found

SS-SP M6. Given: The number.

Find: A fractional part of it.

The numerator in this case is to be one. This variation also includes pure decimal multipliers such as .1 or .01. This is a multiplication variation in grades 5 and 6 and a division variation in grades 3 and 4.

Damani & Ifetayo bought a bag of popcorn together for 54 cents. Each paid ½ of the cost. How much did each one pay?

SS-SP M7. Given: The number.

Find: A fractional part of it.

The numerator of the fraction is greater than one. This variation includes multipliers in decimal form such as .6 or .98.

A bushel of tomatoes weighs 60 lbs. If a tomato is .99 water, how many pounds of water are there in this bushel of tomatoes?

SS-SP M8. Given: A number.

Find: A percent of that number.

Rasta saved 12% on the cost of his car by paying for it in cash. His car costs $15,583.00. How much does he save?

The Meaning of Multiplication for Sutherland

Dr. Sutherland believes that thought patterns M1, M2, M3, M4 and M5 contribute to the notion that multiplication is the process by which the total amount is found when the amount in one group and the number of groups are given.[27] She believes that thought patterns M6, M7, and M8 contribute to a different meaning of multiplication through the use of a fraction or decimal which is defined as finding a fractional part of a number.[28]

Additional Thought Patterns and Variations

Sutherland notes that, "the basic idea in all addition problems is that of combining two or more numbers of the same kind to find their sum."[29] Four variations have been identified which hold to this definition.

SS-SP A1. The phraseology helps emphasize the idea of finding a sum. Here phrases such as "in all," "both," "total," "together," "all together," "the two," "both together," "more," etc. are often found in

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[27] Ibid., p. 94.

[28] Ibid.

[29] Ibid., p. 114.

problems where addition is the process through which the problem is solved.

Larry saw 3 Saint Bernards, 4 Doberman Pinschers, 9 Cocker Spaniels and 5 Afghans at the dog show. How many dogs did he see in all?

SS-SP A2. The phraseology of the problems does not contain characteristic words or expressions such as in A1.

I had $5.36 and earned $9.54. Now I have____?

SS-SP A3. The phraseology of the problem is peculiar to the activity of buying and selling. There are expressions that are characteristic of this pattern. They are "charge," "pay," "spend," "cost," "total cost," "total bill," and "total expenxes."

Karen spent $1.25 for a truck and $13.45 for track shoes. How much did she spend for both?

SS-SP A4. The phraseology is similar to that used in subtraction problems.

Lloyd had some money. He spent $9.33 and had $14.98 left. How much did he have at first?

Anoo has 319 stamps in his collection. His brother Bong has 49 stamps more than he. How many stamps has Bong?

The old barn was 92 feet long. The new barn is 35 feet longer. How long is the new barn?

Sven weighs 115 lbs. which is 25 lbs. below his normal weight. What is Sven's normal weight?

Sutherland believes that any expression characteristic to a pattern or variation helps "to emphasize the underlying

thought of the problem," which in this case is finding the sum.[30] As such, these expressions are not to be used as word-action clues which indicate the process to be used in solving these problems.[31]

The only difference between pattern A1 and A2 is the omission of the characteristic expressions found in A1 from A2. In pattern A4 the four examples presented are similar respectively to pattern variations S1, S5, S6 & S8. In the first example of A4, there is similarity to variation S1 because S1 requires finding the amount left after spending a certain sum.[32]

The wording of the second problem is also somewhat similar to that of variation S5 which compares two numbers by finding how much more one is than the other.[33] The third problem is similar to variation S6 which compares two numbers by finding how much larger one is than the other.[34] Pattern S8 is similar to the fourth problem because S8 compares two numbers by finding their difference, although the word difference is not used in the problem.[35] Sutherland believes that this similarity in phrasing between A4 and certain subtraction variations might lead some pupils to subtract rather than add if they had been taught to look for clues rather than the underlying thought in the problem.[36]

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[30] Ibid., p. 114-115.

[31] Ibid., p. 115.

[32] Ibid., p. 116.

[33] Ibid.

[34] Ibid.

[35] Ibid.

[36] Ibid.

Summary of Sutherland's Concept of Addition

Sutherland believes that the basic idea behind all addition problems is one of combining two or more numbers of the same kind to find their sum. She also believes that the best way for the student to understand when the operation of addition is to be used in a word problem is to present many examples of the various types of addition problems mentioned previously. It will be from a generalization of these experiences that the student understands when the operation of addition is needed in a word problem.

Because the reader has just reviewed a lengthy exploration into the generation and solution of story problems, he is asked to keep in mind that the purpose of their inclusion was to provide a structure on which social studies, science, or literary facts could be stated in such a way that an arithmetic question could be asked and answered.

Social Studies - African Studies (SS - AS)

The motivation for the entire paper stemmed from the concern that the writer had for the low level of mathematical literacy found among African people on both sides of the Atlantic Ocean.[37] Too many Africans who have been raised in countries where they were in the past victims of slavery or in the present, victims of colonialization or neocolonialization have been shown to have low self-

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[37] The word African is used to denote all persons of African descent without regard to their present day nationalities.

concepts of themselves.[38,39,40,41,42] The results have been the feelings of helplessness and hopelessness found within many African communities and the continued colonialization or neocolonialization of those communities. The inclusion of an African studies aspect to this core curriculum is an attempt to deal with those feelings of helplessness and hopelessness.

The following African Studies curriculum objectives have been broken into two parts. The first part deals with the history of the African within the United States and was taken from Taylor and Anderson's An Integrated Approach to Black Studies. The second part deals with the economics, geography and culture of Africans resident to the continent of Africa. It was taken from the Howard County Public Schools Grade 6 Curriculum Guide.

African American History

The reader should know that it was Taylor and Anderson's

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[38]David and Pearl Ausubel, "Ego Development Among Segregated Negro Children," Education in Depressed Areas, edited by Harry Passow, (New York: Teachers College,1963), p. 115.

[39]Mary Ellen Goodman, Race Awareness in Young Children, (New York: Collier Books, 1964), p. 3.

[40]Stokely Carmichael and Charles V. Hamilton, Black Power: The Politics of Liberation in America, (New York: Vintage Books, 1967), p.5.

[41]Kenneth B. Clark, Dark Ghetto, (New York: Harper & Row, 1965), p. 11.

[42]I. F. Stone, "The New York Review of Books." (August 18, 1966), pp. 10,11.

choice to use the designation "Black" for persons descended from African ancestry and although this writer does not agree with the term, its use has been permitted within this paper.

Exploring the New World

Objectives

SS-AS 1. To have students become aware of the contributions of Blacks to exploration.

SS-AS 2. To provide students with the basic knowledge of slavery's beginnings in the new world.

SS-AS 3. To have students begin tracing the history of Blacks in the colonies beginning with the early forms of slavery.

SS-AS 4. To have students realize that Blacks' contributions to the United States began with the discovery of America.

SS-AS 5. To have students develop a positive attitude toward the Blacks in the United States.

The Black Man in Colonial America

SS-AS 6. To develop the understanding that Blacks were brought to the English colonies in 1619.

SS-AS 7. To gain a valid insight into the African heritage of the Black man.

SS-AS 8. To show that slave uprisings caused the colonies to adopt strict laws concerning Blacks.

SS-AS 9. To introduce the idea that the cruelties of slavery led to the emergence of notable abolitionists.

SS-AS 10. To trace Black history during the colonial period.

The American Revolution

SS-AS 11. Students must know when Blacks became involved.

SS-AS 12. Students should know how to trace the attitude of the pre-revolutionary government toward slaves.

SS-AS 13. Students should know that Blacks had an integral role in the Revolutionary War.

SS-AS 14. Students must be aware of contributions by Blacks to the success of the United States in the war.

SS-AS 15. Students must know that Blacks fought for the British and were commended for their actions.

SS-AS 16. Students should be encouraged to keep in mind that Blacks despite slavery, had a deep loyalty to the United States.

Founding of a Nation

SS-AS 17. Make students aware of the fact that the Revolution brought gains to the Blacks.

SS-AS 18. Provide students with information on how the Constitution dealt with slaves.

SS-AS 19. Give the students some background on the formation of abolitionist societies and the Underground Railroad.

SS-AS 20. To examine the role of Blacks in the freedom movement.

SS-AS 21. Make the student aware of how early the fight for emancipation began and what it involved.

Civil War Period and Reconstruction

SS-AS 22. To promote a better understanding of cultural backgrounds through a framework of historical reference during the Civil War and Reconstruction period.

SS-AS 23. To study the contributions made by gallant Black soldiers during the Civil War despite the fact that they were segregated in the army.

SS-AS 24. To relate the many factors that led to the uncertainty in the federal government about Blacks.

SS-AS 25. To remember those Black Americans who helped bring victory to the Union.

SS-AS 26. To have students discover that the Civil War was part of a world movement toward freedom.

SS-AS 27. To relate the significance of the Emancipation Proclamation.

SS-AS 28. To have students able (after having studied the Civil War era) to discuss the Black man's role during the Reconstruction.

SS-AS 29. To have students able to point out significant Black freedmen who joined in the political life of our nation during the Reconstruction.

The Forgotten Years 1877 - 1917

SS-AS 30. Students should be aware of the problems of segregation after the Civil War.

SS-AS 31. Students must know that Blacks have their own traditions and values, and that they don't necessarily have things in common with Whites.

SS-AS 32. Students should be aware of Black contributions despite segregation.

SS-AS 33. Students must know that despite America being a heterogeneous society, discrimination against the Blacks has been more intense and of longer duration.

SS-AS 34. Students should know about the struggle for both segregation and integration.

SS-AS 35. Students must be aware of the ways Blacks fought for integration.

SS-AS 36. Students must have some basic knowledge that Blacks were involved in every aspect of life in the United States.

The Progressive Era 1900 - 1915

SS-AS 37. Have students trace the role of Blacks during this Era.

SS-AS 38. Give students a clear-cut picture of what the Progressive Era did for Blacks.

SS-AS 39. Help students realize that despite many obstacles placed in the path of Blacks, they were still able to advance.

SS-AS 40. Have students be aware of how the White Society reacted to the struggles of Blacks.

SS-AS 41. Provide students with background information on discriminatory practices against Blacks.

SS-AS 42. Have students know of the contributions of Black leaders and organizations.

SS-AS 43. Encourage students to do research on one of the topics in the outline.

SS-AS 44. Have students know about the intellectual and cultural contributions made by Blacks.

Great Depression and the New Deal

SS-AS 45. To teach students how Black Americans were affected during the Great Depression.

SS-AS 46. To make students aware of why more Blacks were unemployed than Whites.

SS-AS 47. To have students discover how the "last hired-first fired" concept led to organized Black groups.

SS-AS 48. To have students learn about the "Black Cabinet" formed in Washington, D.C.

SS-AS 49. To introduce to students Mary McLeod Bethune and other members of the "Black Cabinet." Who played important parts in the New Deal?

SS-AS 50. To have students study how the New Deal changed the lives of many Black Americans.

SS-AS 51. To show students how relief programs were instituted to aid people in need.

SS-AS 52. To have students develop positive attitudes toward Blacks.

World War II

SS-AS 53. To know how Blacks joined the fight against fascism during World War II.

SS-AS 54. To know how Blacks helped the war effort in the United States.

SS-AS 55. To be aware of discriminatory practices in the armed forces.

SS-AS 56. To give students some background of the constant struggle for Blacks' rights at this time.

SS-AS 57. To provide students with information on how World War II affected Blacks.

SS-AS 58. To have students know how the federal government under President Truman helped civil rights.

The Civil Rights Revolution

SS-AS 59. Students should discover how the N.A.A.C.P. lawyers ended the idea that "separate but equal" was allowed by the Constitution.

SS-AS 60. Students should learn how Black leaders emerged to improve the civil rights of Black Americans.

SS-AS 61. Students should study discriminatory practices that eventually led to protest movements.

SS-AS 62. Students should realize that non-violence and civil disobedience were accepted by Black leaders in the South.

SS-AS 63. Students should discover how the peaceful boycott became a new weapon in the struggle to end discrimination.

SS-AS 64. Students should review how the success of a bus boycott in Montgomery, Alabama brought the country a new leader, Dr. Martin Luther King.

SS-AS 65. Students must become aware that non-violent sit-ins and freedom rides were met with violence.

SS-AS 66. Students should discover that Whites and Blacks worked together to get more Black Americans to vote.

SS-AS 67. Students should become acquainted with important Black Americans in our country from the past to the present.

SS-AS 68. Students should learn that new voting laws have brought Black people into politics all over the country.

SS-AS 69. Students should realize, by studying this unit, the determination of Blacks to be free and to be recognized as important people in a multi-cultural society.

Africans Resident to the Continent of Africa

The Howard County Public Schools Social Studies Curriculum lists nine objectives for its unit on Africa. These are as follows.

SS-AS 70. The student will identify Africa as a continent.

SS-AS 71. The student will list those aspects of daily living in Africa which are universal to all mankind such as food, clothing, shelter, socialization.

SS-AS 72. The student will compare the aspects of daily living in Africa with those same aspects of daily living in North America.

SS-AS 73. The students will evaluate a variety of resource material.

The students will locate or gather information from materials placed at learning stations either working independently or in a group.

SS-AS 74. The student will identify the economic, political, and social contributions, made by Africa and Africans to the contemporary world.

SS-AS 75. The student will interpret and construct various maps of Africa.

SS-AS 76. Students will interpret information on Africa using various charts and graphs.

SS-AS 77. Students will organize and analyze data as well as arrive at some conclusions.

Science Competencies

In this part of the core curriculum, a decision was made to utilize the processes of science and the scientific method as competencies and not to use a selected body of scientific information such as the reasons why volcanoes erupt or why rain falls. It was believed that these processes and the scientific method were the basics by which new information was added to what the public called science. The following competencies have been taken from the Science Program Planning Guide K-12 published by the Saint Vrain Valley Public Schools of Longmont, Colorado. In this section, the science competencies were preceded by the letters "Sc." This was done as an aid for later notation.

Main Science Education Goals

The student will demonstrate the abilities and skills needed to engage in the processes of science.

Supporting Science Education Goals

Demonstrates an understanding of the process of observing.

Sc 1. Observes a single object in terms of its physical properties (e.g., color, size, shape, texture, height).

Sc 2. Observes likenesses and differences among single objects.

Sc 3. Observes likenesses and differences among sets of objects.

Sc 4. Observes and classifies relative terms.

Sc 5. Observes objects using each of the five senses.

Sc 6. Determines physical properties of an object by manipulating without visual aid.

Sc 7. Identifies a changing property in a series of pictures.

Sc 8. Demonstrates an ability to observe changes in the properties of objects.

Demonstrates an understanding of the process of classifying.

Sc 9. Identifies similarities and differences in the properties of objects.

Sc 10. Orders objects within categories which have been classified.

Sc 11. Classifies objects on a basis of "derived" characteristics requiring a kind of measurement.

Sc 12. Classifies likenesses and differences among rates of change.

Sc 13. Classifies and orders relationships of physical events.

Sc 14. Classifies events on the basis of inferred variables.

Sc 15. Distinguishes the classes of events involved in "indirect" observations.

Sc 16. Divides objects into groups based upon given or student-generated criteria.

Sc 17. Divides objects into groups in several different ways.

Sc 18. Classifies objects using each of the five senses.

Sc 19. Sorts a collection of objects and/or organisms as living or non-living.

Sc 20. Sorts a collection of objects and/or organisms as natural or man-made.

Sc 21. Sorts a collection of organisms as plant or animal.

Sc 22. Describes the relationship between parts of a system or objects and/or organisms.

Sc 24. Subdivides a set of unfamiliar objects into several categories of increasing inclusiveness.

Sc 25. Selects object(s) exhibiting two or more properties from a set.

Sc 26. Selects all objects with the specified common properties from a set of five or more objects that vary in property.

Sc 27. Selects all objects of a specified shape from a set of ten 2- or 3-dimensional objects.

Sc 28. Selects an object which exhibits a property to the greatest (least) extent from a set of five objects.

Sc 29. Selects from a set of objects the set that is numerically larger than or smaller than another.

Sc 30. Sorts a collection of objects into two sets on the basis of a common property.

Sc 31. Identifies a property from two classified sets of objects and/or organisms which is common only to one set.

Sc 32. Identifies from a collection of objects and/or organisms the set which exhibits specific relationships.

Demonstrates an understanding of the process of ordering.

Sc 33. Arranges objects in sequence according to properties (e.g., color, weight, texture, size).

Sc 34. Arranges objects in sequence according to number.

Sc 35. Orders a series of observations.

Sc 36. Describes a series of events in sequence.

Sc 37. Arranges living objects in a sequence according to development.

Sc 38. Organizes and analyzes ordered matrices.

Demonstrates an understanding of the process of measuring and using numbers.

Sc 39. Selects and uses appropriate units and instruments for measuring.

Sc 40. Uses measurements for various purposes including identification of quantities, accurate comparisons and meaningful communication of information.

Sc 41. Explains how and why units are defined and standardized.

Sc 42. Uses standard procedures for accurate measurement.

Sc 43. Determines degrees of precision and accuracy needed for purposes of measurement.

Sc 44. Uses appropriate scientific notation for accurately recording measurements.

Sc 45. Devises a method for determining the size of an object in relation to an unmarked standard.

Sc 46. Measures accurately in metric units.

Sc 47. Selects and uses metric units of length appropriate to purpose.

Sc 48. Selects and uses appropriate instruments or devices for measuring length, mass and time.

Sc 49. Calculates areas from length unit measurements and expresses answers in length units squared.

Sc 50. Uses graduated cylinders or containers to measure volume in metric units.

Sc 51. Measures angles using and selecting appropriate procedures and instruments.

Sc 52. Recognizes that an angle is a property of space and rotation: the angle between two lines is the amount of rotation necessary to make lines parallel.

Sc 53. Uses angular units to identify position (latitude, longitude).

Sc 54. Measures intervals of time in standardized units.

Sc 55. Compares mass of unknown object with known object.

Sc 56. Measures mass in metric units (e.g., kilograms, grams) using appropriate instruments.

Sc 57. Selects and uses appropriate units of energy in various forms.

Sc 58. Recognizes that power is the rate of doing work: $P = w/t$.

Sc 59. Measures weight with a spring scale and recognizes that weight is a measure of the force of gravity distinct from mass.

Sc 60. Measures temperature in metric (Celsius) or English (Fahrenheit) units as a position on a scale of an appropriate instrument.

Sc 61. Identifies zero degrees C as the freezing/melting point of water and 100 degrees C as the boiling point of water with equal intervals (degrees) in between.

Demonstrates an understanding of spatial-temporal relationships.

Sc 62. Distinguishes two-dimensional shapes by matching them with their outlines.

Sc 63. Identifies common regular three-dimensional shapes by matching objects that vary in size.

Sc 64. Distinguishes near-far, high-low, with reference to the student's own position, and to other positions in space.

Sc 65. Identifies points, straight and curved lines, relative distances, angles, common shapes such as rectangles and triangles in unfamiliar objects or environments.

Sc 66. Represents non-quantitatively by rough drawings points, lines, angles, and two-dimensional shapes.

Demonstrates an understanding of the process of inferring and predicting.

Sc 67. Distinguishes between observed events and inferred states.

Sc 68. Interprets unfamiliar phenomena, described in non-technical language, in terms of reasonable inferences.

Sc 69. Constructs and tests predictions from experimental data.

Sc 70. Selects from a list of activities those that would best confirm or negate a prediction.

Sc 71. Explains the difference between inferring and predicting.

Sc 72. Selects from a set of observations those that best support an inference.

Sc 73. Selects inferences which account for observations from a set of observations and inferences.

Sc 74. Identifies at least one way an inference can be tested.

Demonstrates an understanding of recording, representing, communicating, and interpreting data in oral, written, pictorial, tabular, or graphic form.

Demonstrates an understanding of reading skills, vocabulary, symbols, formula, etc.

Sc 75. Applies reading skills to the field of science (e.g., phonetic analysis, structured analysis, comprehension).

Sc 76. Recognizes that reading scientific material involves a different type of reading skill.

Sc 77. Demonstrates an understanding and comprehension of words and terms by using accurate terms for distance, size, shapes, symbols, colors,

temperatures, textures, tastes and odors, time relationships, rates, directions, and kinds of motion in appropriate meaningful statements or discriminating in choice.

Sc 78. Indicates knowledge of vocabulary specific to science (e.g., names of elements, species).

Demonstrates an understanding of resource usage and data gathering.

Sc 79. Uses appropriate techniques to efficiently locate specific directions as needed for references.

Sc 80. Identifies sources of scientific materials (e.g., television, film, radio, filmstrips, magazines, newspapers, scienific journals, textbooks, encyclopedias, personal observation).

Sc 81. Distinguishes between statements of fact and statements of opinion.

Sc 82. Locates parts of a book and understands their functions (e.g., table of contents, index, glossary, bibliography, appendix).

Sc 83. Demonstrates an understanding of library skills (e.g., Reader's Guide to Periodic Literature, card catalog).

Sc 84. Selects from written materials statements that are relevant to the problem being studied.

Demonstrates an understanding of reading, representing, and communicating data in various ways.

Sc 85. Interprets scientific drawings, pictures, charts, classification tables, graphs, and maps, etc.

Sc 86. Records information in a variety of ways (e.g., written notes, tape recordings).

Sc 87. Selects and uses recording systems which are appropriate to the subject (e.g., graphs, tables, notes).

Sc 88. Records information clearly and accurately.

Sc 89. Classifies, sorts, and organizes information so that things having common characteristics are found together.

Sc 90. Records observed information in simple tabular form.

Sc 91. Describes orally or in writing the objects used, events, and changes in simple experiment.

Sc 92. Describes in an organized fashion, in both oral and written communication, the characteristics of specific objects in verifiable language and in terms of scientifically relevant categories.

Sc 93. Describes the conditions of an experiment in terms of what the experimenter does; the variables employed; the measurements taken from an investigation or from a brief statement of purpose for an investigation.

Demonstrates an understanding of constructing and interpreting graphs.

Sc 94. Interprets different types of graphs (e.g., bar, pictograph, line, circle).

Sc 95. Identifies trends and extrapolates from a bar graph.

Sc 96. Draws or explains a bar graph which indicates the change of something over time.

Sc 97. Constructs a graph or table describing the relationship between two or more variables.

Sc 98. Uses graphs to determine the validity of experimental data.

Demonstrates an understanding of building and using scientific models.

Sc 99. Constructs real, mental, and verbal models that aid in visualizing objects, phenomena, and principles of science.

Sc 100. Uses models to help decode scientific information (e.g., graphic, 3-dimensional, dynamic forms).

Demonstrates an understanding of fundamental laboratory skills and safety procedures.

Sc 101. Uses the various specialized measurement tools, laboratory ware, sense extenders, and electronics used by various disciplines.

Sc 102. Locates, uses properly, and returns or stores equipment.

Sc 103. Recognizes that the accuracy and effectivenss of equipment and sense extender depends upon their control, use, and maintenance.

Sc 104. Uses common materials appropriate for laboratory experiments or demonstrations.

Sc 105. Follows directions for safe and valid conduction of experiments, observation, and demonstrations found in lab manuals, scientific texts, workbooks, etc.

Sc 106. Demonstrates a concern for the rights, property, and safety of others in the laboratory.

Sc 107. Demonstrates proper concern for the safe and effective use of laboratory chemicals.

Main Science Education Goal

The student will demonstrate an understanding of the investigative nature of science.

Supporting Science Education Goals

Demonstrates an understanding of the scientific method.

Demonstrates an understanding of the steps of experimenting and the scientific method.

Sc 108. Recognizes that the classic scientific method refers to the sequence of processes common to most inquiry strategies.

Sc 109. Recognizes the scientific method has been developed as a means of validating new information or re-concluding conflicting information.

Demonstrates an understanding of the process of identifying and defining a scientific problem or question to be investigated.

Sc 110. Identifies, recognizes, states, or defines the problem or quesiton to be investigated.

Sc 111. Defines scientific questions and problems operationally.

Demonstrates an understanding of hypothesizing.

Sc 112. Formulates hypothesis based on available information (e.g., logical generalization about relationships between variables or factors in a situation).

Sc 113. Makes predictions based on a hypothesis.

Sc 114. Predicts outcomes of a hypothesis.

Sc 115. Distinguishes among hypothesis, prediction, inferences, observations, facts, opinions.

Demonstrates an understanding of proposing and selecting logical tests of a hypothesis.

Sc 116. Designs tests to prove a hypothesis (e.g., controlled experiment, observation, survey).

Sc 117. Carries out structured observations to test hypothesis (e.g., behavioral observations, field study).

Sc 118. Selects and uses appropriate procedures, instruments, and materials to test a hypothesis.

Sc 119. Collects data to test hypothesis.

Sc 120. Modifies hypothesis, explanations, and predictions in light of new factors, variables, evidence and considerations.

Demonstrates an understanding of testing the effects of variables and controlling relevant variables.

Sc 121. Carries out controlled experiments.

Sc 122. Recognizes that in a controlled experiment all variables are held constant except the one whose effect is being tested.

Sc 123. Identifies variables.

Sc 124. Distinguishes between controllable and non-controllable variables in a system which can be replicated.

Demonstrates an understanding of evaluating data, drawing logical conclusions, and generalizing results.

Sc 125. States conclusions or generalizaitons drawn from test data.

Sc 126. Compares and contrasts experimental or observational data from several sources.

Sc 127. Analyzes and interprets graphs, tables, charts, and diagrams to arrive at generalizations or conclusions.

Sc 128. Recognizes that analysis is the study of a whole by systematic evaluation of its parts and the relationships between them.

Sc 129. Formulates logical generalizations from experimental or observational data.

Sc 130. Applies generalizations to interpretations of information and understands this to be deduction (deductive reasoning, deductive logic).

Sc 131. States a generalization from interpretations of information through the process of inductive reasoning.

Sc 132. Identifies generalizations as abstractions (e.g., statements about relationships between concepts or represented factors).

Sc 133. Recognizes various kinds of generalizations as scientific laws, principles, conclusion.

This completes this writers listing of the competencies for this math core curriculum. It should be understood that the math competencies are not the entire set for that subject but comprise a very small number. It is not this writer's purpose to list every math competency nor every social studies, science, or language arts competency. The purpose is to define a core curriculum in his terms, provide a model of the use of such a curriculum, to prepare a taxonomy for such a curriculum and to provide a lesson plan based on such a curriculum.

A Taxonomy for A Math Core Curriculum

Below are the math, social studies, science and language arts competencies listed earlier in this paper. They are listed with the same notation they had in the previous section.

To use the taxonomy, the teacher must decide which ideas he wishes to link. He may decide to link a math idea at the top of the first page of the taxonomy with a language arts idea on the bottom of that page. He may decide to link a math idea with social studies ideas on the second and third pages of the taxonomy and a science idea on the first page.

It is suggested that the teacher using this type of curriculum let the students progress from one math competency to the next and not skip competencies. One must remember that in this core curriculum, the idea behind most lessons is a math idea. A lesson can begin in the math core and then be developed or analyzed in another area of the curriculum. It can also work in the reverse wherein the teacher plans a lesson that begins in an area other than the math core but has as its objective the emphasis of an idea in the core. It is also understood that this curriculum is not limited to those ideas in the math core and their interactions with other curriculum areas. The teacher should feel free to explore deeply other areas as long as he plans to return to the core concept approach. The Math Core Curriculum Taxonomy follows.

Math Competencies	Language Arts Competencies	Social Studies Competencies	Science Competencies
Rational No. Facts	Listening Skill	Citizenship	The Process
M1	LA1	SS-C1	of Science
M2	LA2	SS-C2	Observing
M3	LA3	SS-C3	Sc1
M4	LA4	SS-C4	Sc2
M5	Speaking	SS-C5	Sc3
M6	LA5	SS-C6	Sc4
M7	LA6	SS-C7	Sc5
M8	LA7	SS-C8	Sc6
M9	LA8	SS-C9	Sc7

Math Competencies	Language Arts Competencies	Social Studies Competencies	Science Competencies
M10	LA9	SS-C10	Sc8
M11	LA10	SS-C11	Classifying
M12	Reading	SS-C13	Sc9
M13	LA11	SS-C14	Sc10
M14	LA12	SS-C15	Sc11
M15	LA13	SS-C16	Sc12
M16	LA14	History	Sc13
M17	LA15	SS-H	Sc14
M18	LA16	Newspaper	Sc15
M19	LA17	SS-N1	Sc16
M20	LA18	SS-N2	Sc17
M21	LA19	SS-N3	Sc18
M22	LA20	SS-N4	Sc19
M23	Writing	SS-N5	Sc20
M24	LA21	Number Puzzles	Sc21
M25	LA22	SS-NP	Sc22
M26	LA23	Story Problems	Sc23
M27	LA24	Subtraction	Sc24
Rational No.	LA25	SS-SPS1	Sc25
Addition	LA26	SS-SPS2	Sc26
M28	LA27	SS-SPS3	Sc27
M29	LA28	SS-SPS4	Sc28
M30	LA29	SS-SPS5	Sc29
M31	Study	SS-SPS6	Sc30
M32	LA30	SS-SPS7	Sc31
M33	LA31	SS-SPS8	Sc32
M34	LA32	SS-SPS9	Ordering
Rational No.	LA33	SS-SPS10	Sc33
Subtraction	LA34	Division - The	Sc34
M35	LA35	Measurement	Sc35
M36	Personal Commu-	Concept	Sc36
M37	nication and	SS-SPD1	Sc37
M38	Development	SS-SPD2	Sc38
Rational No.	LA36	SS-SPD3	Measuring
Multiplication	LA37	SS-SPD4	Sc39
M39	LA38	SS-SPD5	Sc40
M40	LA39	SS-SPD6	Sc41
M41	Literary Analysis	SS-SPD7	Sc42
M42	LA40	SS-SPD8	Sc43
M43	LA41	Division - The	Sc44
M44	LA42	Partitive Concept	Sc45
M45	LA43	SS-SPD9	Sc46
Rational No.	LA44	SS-SPD10	Sc47
Division		SS-SPD11	Sc48
M46		SS-SPD12	Sc49
M47		SS-SPD13	Sc50
M48		SS-SPD14	Sc51
M49		SS-SPD15	Sc52

Math Competencies	Language Arts Competencies	Social Studies Competencies	Science Competencies
M50		SS-SPD16	Sc53
M51		Multiplication -	Sc54
M52		Total Amount	Sc55
		SS-SPM1	Sc56
		SS-SPM2	Sc57
		SS-SPM3	Sc58
		SS-SPM4	Sc59
		SS-SPM5	Sc60
		Multiplication -	Sc61
		Fractional Part	Spatial - Temporal
		SS-SPM6	Relationships
		SS-SPM7	Sc62
		SS-SPM8	Sc63
		Addition	Sc64
		SS-SPA1	Sc65
		SS-SPA2	Sc66
		SS-SPA3	Inferring and
		SS-SPA4	Predicting
		African Studies	Sc67
		U.S.A.	Sc68
		Exploring the	Sc69
		New World	Sc70
		SS-AS1	Sc71
		SS-AS2	Sc72
		SS-AS3	Sc73
		SS-AS4	Sc74
		SS-AS5	Recording and
		Colonial America	Interpreting
		SS-AS6	Data
		SS-AS7	Sc75
		SS-AS8	Sc76
		SS-AS9	Sc77
		SS-AS10	Sc78
		American	Sc79
		Revolution	
		SS-AS11	Resource Usage
		SS-AS12	and Data
		SS-AS13	Gathering
		SS-AS14	Sc80
		SS-AS15	Sc81
		SS-AS16	Sc82
		Founding A	Sc83
		Nation	Sc84
		SS-AS17	Sc85
		SS-AS18	Reading, Repre-
		SS-AS19	senting and com-
		SS-AS20	municating Data
		SS-AS21	Sc86
		Civil War and	Sc87
		Reconstruction	Sc88

Math Competencies	Language Arts Competencies	Social Studies Competencies	Science Competencies
		SS-AS22	Sc89
		SS-AS23	Sc90
		SS-AS24	Sc91
		SS-AS25	Sc92
		SS-AS26	Sc93
		SS-AS27	Sc94
		SS-AS28	Constructing and
		SS-AS29	Interpreting
		Forgotten Years	Graphs
		1877-1917	Sc95
		SS-AS30	Sc96
		SS-AS31	Sc97
		SS-AS32	Sc98
		SS-AS33	Sc99
		SS-AS34	Building and
		SS-AS35	Using Models
		SS-AS36	Sc100
		Progressive	Sc101
		Era	Laboratory
		SS-AS37	Skills
		SS-AS38	Sc102
		SS-AS39	Sc103
		SS-AS40	Sc104
		SS-AS41	Sc105
		SS-AS42	Sc106
		SS-AS43	Sc107
		SS-AS44	Sc108
		Great Depression	Scientific Method -
		New Deal	Steps of
		SS-AS45	Experimenting
		SS-AS46	Sc109
		SS-AS47	Sc110
		SS-AS48	Identification
		SS-AS49	& Definition
		SS-AS50	Sc111
		SS-AS51	Sc112
		SS-AS52	Hypothesizing
		World War II	Sc113
		SS-AS53	Sc114
		SS-AS54	Sc115
		SS-AS55	Sc116
		SS-AS56	Testing Hypothesis
		SS-AS57	Sc117
		SS-AS58	Sc118
		Civil Rights	Sc119
		Revolution	Sc120
		SS-AS59	Sc121
		SS-AS60	Testing and
		SS-AS61	Controlling

Math Competencies	Language Arts Competencies	Social Studies Competencies	Science Competencies
		SS-AS62	Variables
		SS-AS63	Sc122
		SS-AS64	Sc123
		SS-AS65	Sc124
		SS-AS66	Sc125
		SS-AS67	Evaluating Data
		SS-AS68	Sc126
		SS-AS69	Sc127
		African Studies	Sc128
		Africa	Sc129
		SS-AS70	Sc130
		SS-AS71	Sc131
		SS-AS72	Sc132
		SS-AS73	Sc133
		SS-AS74	
		SS-AS75	
		SS-AS76	
		SS-AS77	
		SS-AS78	

A Lesson Plan Utilizing the Math Core Curriculum Concept

Math Core Objective - M18

The student knows equivalent fractions may be produced by multiplying by an appropriate form of one.

Math/Language Arts Activity

The teacher states the objective in terms that the students understand - then states what she and they will do.

The teacher demonstrates with pencils, rulers, newsprint, and teacher-drawn diagrams the conversion of 3/4 of a rectangle to 6/8 of a rectangle.

LA3, LA5 - The teacher asks for an explanation of what she did and how she did it.

The teacher guides one student through the conversion of 3/4 to 9/12 using the above materials. The student is demonstrating the technique to the class.

LA3, LA5 - The teacher asks for an explanation of what the student did and how he did it.

The teacher asks the students to take out their drawing materials.

LA1, LA3 - The students comply and convert the following fractions to their equivalents.

2/3 to 6/9, 1/2 to 4/8, 7/9 to 35/45, 5/8 to 35/56, 3/9 to 18/54, 9/10 to 99/110

The teacher tells the students to use the following equivalents respectively for the above conversions.

3/3, 4/4, 5/5, 6/6, 7/7, 11/11

LA3, LA5 - The teacher evaluates the progress of the students in their groups by asking questions of individuals and getting oral replies.

LA21 - 24, LA26 - The teacher asks for a written explanation of the conversion of 9/10 to 99/110 of all the students.

Math/Social Studies

SS - NP and SS - AS60, 62, 67, 69

Teacher made number puzzle on Stokely Carmichael. Example follows.

N_____

D_____

Number Puzzle - Fractional Equivalence

1. Simplify the fractions.
2. Place the letters associated with the answers in the spaces provided.

A	B	C	D	E	F	G
4/8 =	30/35 =	6/14=	2/20=	20/32=	8/18=	28/32=

H	I	J	K	L	M
6/21=	18/54=	8/8=	27/3=	8/12=	12/15=

Fill in the spaces.

N	O	P	Q	R
1/3 · =9/27	5/6· =30/36	1/5· =2/10	7/1· =21/3	3/5· =33/55

S	T	U	V	W
1/4· =4/16	1/8· =7/56	4/1·2/2=	2/5·6/6=	3/4·3/3=

X	Y	Z
3/8·6/6=	3/10·5/5=	3/7· =15/35

Number Puzzle

4/4 7/7 6/6 9/1 5/8 3/4 15/50 3/7 1/2 11/11 4/5 1/3 3/7 2/7 1/2 5/8 3/4 was born in Trinidad and got 2/7 1/3 4/4 5/6 1/2 3/7 1/3 5/8 3/4 6/6 11/11 4/4 1/10 5/8 7/8 11/11 5/8 5/8 4/9 11/11 6/6 4/5 2/7 6/6 9/12 1/2 11/11 1/10 8/2 9/9 1/3 12/30 5/8 11/11 4/4 1/3 7/7 15/50 in 1964 in the field of 2/2 2/7 1/3 3/4 6/6 4/4 6/6 2/2 2/7 15/50. He helped start the 4/4 7/7 8/2 1/10 5/8 9/9 7/7 9/9 6/6 9/9 12/30 1/3 6/6 3/4 5/8 9/9 7/7 3/7 6/6 6/6 11/11 1/10 1/3 9/9 1/2 7/7 1/3 9/9 7/8 in 1960 and became its chairman in 3/7 6/6 4/5 4/5 1/3 7/7 7/7 5/8 5/8 1966. He has gone to jail on many occasions in order to guarantee African Americans the right 7/7 6/6 12/30 6/6 7/7 5/8. He is now one of the leading 7/7 2/7 1/3 9/9 9/1 5/8 11/1 4/4 in the 2/2 1/2 9/9 - 1/2 4/9 11/11 1/3 - 3/7 1/2 9/9 1/3 4/4 7/7 Movement to 8/2 9/9 1/3 4/9 15/50 the continent of 1/2 4/9 11/1 1/3 3/7 1/2 under 4/4 3/7 1/3 5/8 9/9 7/7 1/3 4/9 1/3 3/7 - 4/4 6/6 3/7 1/3 1/2 3/4 1/3 4/4 4/5.

Math/Science

The students should conduct the following flammability experiment. The following science objectives are used in this experiment:

Sc5, 8, 16, 39, 40, 42, 60, 85, 86, 87, 88, 89, 90, 101, 102, 103, 104, 105, 106, 107.

N_____

D_____

Flammability

Directions:

1. You are to find out at which temperatures certain articles become flammable or if they become flammable.

2. Put your findings in chart form.

3. Answer all questions.

Equipment necessary:

1. Bunsen burners
2. hot plates
3. thimbles
4. wire
5. eye droppers
6. spoons
7. metal dishes
8. toothpaste
9. tar
10. toothpicks (8-9)
11. paper (1 - 8½ X 11 sheet)
12. human hair (3-4 very small strands from each person)
13. plastic bag
14. rubbing alcohol
15. motor oil
16. fingernail clippings
17. fiberglass (angel hair, Christmas decoration)
18. 1 beaten egg per group
19. popcorn kernels
20. rice kernels
21. Brewer's yeast
22. baking soda
23. tweezers
24. thermometers
25. stands
26. screens
27. brushes

Make a Flammability Chart

At the top of one column you'll have the words, "Articles Tested."
At the top of the second column you'll have the listing of the temperature of the coil when it's at the simmer temperature.
The third column will be used for the flame's temperature.
The fourth column will be labeled non-flammable.
This column is checked only if an article has not caught fire at the high or low temperatures.

Caution:

In conducting the experiments use no more than ½ thimble of alcohol or motor oil. Use the wire to wrap around the lip of the thimble once so that you can steady it. Also, brush the egg yolk on the screens and let it dry before heating.

Questions:

1. What is the temperature at the top of the Bunsen burner flame?

2. What is the temperature of the coil of the hot plate when it is at the simmer setting?

3. Set up your stand and test which articles are flammable at the top of the flame. Put a check in the appropriate column if they are.

4. Test which articles are flammable at the simmer setting on the hot plate. Put a check in the appropriate column of the chart if it is.

5. If you had the following amounts of the tested article, what would your total amount be?

   1 oz. toothpaste
   ½ oz. tar
   2/3 oz. toothpicks
   3/4 oz. paper
   4/5 oz. human hair
   5/6 oz. plastic bags
   7/10 oz. rubbing alcohol
   11/12 oz. motor oil
   13/15 oz. fingernail clippings
   11/20 oz. fiberglass
   7/30 oz. egg yolk
   17/60 oz. popcorn kernels
   1/3 oz. rice kernels
   1/4 oz. Brewer's yeast
   2/5 oz. baking soda

6. What would be the total weights of the

   a. high temperature flammables?

   b. low temperature flammables?

   c. the non-flammables?

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